

## INTRODUCTION

# GO | Procedural

The creation of 3D animation and visual effects involves a number of stages which come together to create a complete artistic vision. Throughout this process, 3D artists like yourself explore and refine ideas in order to meet the creative needs of the project while hitting many tight deadlines.

With Houdini, you have access to a node-based procedural workflow which makes it easier to manage and control the underlying flow of data which defines how your models, materials, animation and visual effects are working. This control makes it easier to step in and make changes where needed as the nodes update to show the new results. This frees you up to explore and prototype ideas early in production then come back and refine and scale the solution to create final shots.

As you work through these lessons, you will see how Houdini's procedural approach has been designed from the ground up to support artists and technical directors working in production. Its procedural architecture makes it easier for you to create directable CG shots, explore multiple iterations and hit deadlines no matter how tight they are. And most importantly, you will accomplish all of this using a friendly set of tools which are easy to access.

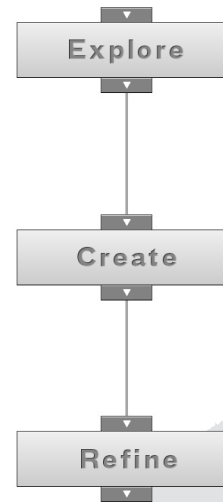
## WHAT YOU WILL LEARN FROM THIS GUIDE

In this user guide, you will learn how to navigate Houdini's user interface and work with its node-based workflow to create 3D animations and visual effects. You will be amazed how much you can accomplish and how quickly you will acquire new skills.

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

**If you are new to the 3D world** then Houdini is a great package to start with. This book does go at a healthy pace, therefore you should also read about general CG concepts to help you keep up. In the end, you will achieve a deeper understanding of how CG works, which will benefit you throughout your career.

When you finish this book, you can visit [www.sidefx.com](http://www.sidefx.com) and find more tutorials. Go to **Learning > Learning Roadmap** for a comprehensive list of available materials.



## DOWNLOAD HOUDINI FOR FREE

A free learning edition of Houdini is available for you to work through these 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 a watermark.

To download Houdini go to [www.sidefx.com/apprentice](http://www.sidefx.com/apprentice) where you can also get new versions which are updated regularly.

## THE APPRENTICE PROGRAM

The Apprentice program offers much more than just a learning edition of Houdini. Artists and students can use the Apprentice edition to develop projects which are non-commercial in nature.

In addition, **Houdini Apprentice HD** is available which removes the watermark and offers higher render resolutions. This program makes Houdini a great tool for developing personal work and building up your demo reel.

## The World of Houdini

For years, CG artists have been turning to Houdini to help create blockbuster movies and award-winning commercials. Known as the software used to handle the biggest challenges, Houdini has grown into a well-rounded solution for studios big and small.

# Houdini

3D ANIMATION TOOLS

2

### SIDE EFFECTS SOFTWARE

Houdini is created by Side Effects Software, a company which has been developing software since 3D computer graphics first began playing a role in the entertainment industry. Side Effects was the first company to put a graphical user interface on a procedural modeling system and, over the years, our technology has grown and evolved into the Houdini used today by top studios around the world.

For Side Effects, the goal has always been to create high quality software for digital artists. Side Effects' award winning solutions have been used in thousands of shots in hundreds of feature films. Typically used for visual effects, CG art created in Houdini can also be found in commercials and video games.

Houdini's comprehensive feature set includes modeling, rigging, animation, particle effects, dynamics, compositing, integrated rendering, and more. Houdini is available for the **Mac OS X, Linux** and **Windows** operating systems.

While Side Effects is best known for its software, customers also benefit from fully integrated partner relationships that include exceptional customer support full on-site production services and access to daily software updates.

Equally important is Side Effects commitment to the growth of skills in the industry as witnessed by the **Houdini Apprentice program**, which gives digital artists the chance to build skills and create demo reel content in Houdini for free.

Side Effects is driven by a **Passion for Production** and a focus and commitment that keeps the company at the forefront of innovation and market leadership in the 3D computer graphics industry.

To learn more about Side Effects Software visit the company website at [www.sidefx.com](http://www.sidefx.com).

### MILESTONES

**1987** - Side Effects releases the world's first procedural animation software called PRISMS.

**1996** - Houdini 1 is released providing a next-generation framework for the procedural technologies first introduced in PRISMS.

**1998** - Side Effects wins a Technical Achievement Award from the Academy of Motion Pictures and Science for their work on procedural animation.

**1999** - Houdini 4 is the first major 3D animation package available for Linux.

**2002** - Side Effects launches the Houdini Apprentice Program which provides free 3D animation software to artists and students.

**2003** - Side Effects wins a Science and Engineering Award from the Academy of Motion Pictures and Science in recognition of their work on procedural modeling and animation.

**2003** - Houdini Digital Assets introduce the ability to extend Houdini's procedural ideas out into the wider production pipeline.

**2005** - Houdini is released with integrated Dynamics which make it possible for multiple solvers such as Rigid Body, Wire and Cloth to work together.

**2007** - Side Effects launches Houdini 9, with a fun, easy to learn UI. This new version also adds Fluids.

**2007** - Houdini Apprentice HD: The Starving Artist Edition is introduced allowing artists and students to render watermark-free in HD quality.

**2008** Houdini is released for Mac OS X with support for 64-bit Intel-based Macs.

**2009** - Houdini 10 is released with new Pyro FX tools and distributed fluid simulations.

**2010** - Houdini 11 is released with a new shader building workflow, FLIP particle fluids and dynamic fracturing tools.

### HOUDINI IN PRODUCTION

There are several different Houdini products available. Which one you need will depend on your work:

**Houdini FX** – Perfect for visual effects artists and technical directors with its integrated particle and dynamics toolset. This version also has all of Houdini's features for a complete toolset.

**Houdini** – Ideal for modelers, lighters, character riggers and animators. Houdini also includes features such as compositing and motion editing. Scenes and Digital Assets created in Houdini FX can be opened and rendered with base Houdini and all nodes and assets remain intact.

**Mantra** – All Houdini products come with Mantra which is Houdini's production-proven renderer.

**Houdini Batch** – Houdini Batch is a non-graphical version of Houdini FX which can be deployed on the farm for processing simulations, generating output files for rendering or managing assets.

To learn how the different Houdini products work in production, check out the pipeline diagram on page 6.

Professional Editions		Personal Editions			
Houdini FX	Houdini	Apprentice HD	Apprentice	Education	Product
-	-	-	✓	-	Render Watermark
.hip	.hip	.hipnc	.hipnc	.hipnc	File Format
Unlimited	Unlimited	1920x1080	720x576	Unlimited	Render Limit
✓	✓	✓	✓	✓	Modeling
✓	✓	✓	✓	✓	Animation
✓	✓	✓	✓	✓	Character
✓	✓	✓	✓	✓	Lighting
✓	✓	✓	✓	✓	Mantra Rendering
✓	✓	✓	✓	✓	Render to Amazon Cloud
✓	✓	-	-	✓	Third Party Rendering
✓	✓	✓	✓	✓	Compositing
✓	-	✓	✓	✓	Particles
✓	-	✓	✓	✓	Dynamics
IN/OUT	IN/OUT	IN	IN	IN/OUT	FBX

### PERSONAL PROJECTS AND LEARNING

For CG artists who are working on shots to spruce up their demo reel, developing new skills, or working on personal projects, Side Effects has created the **Houdini Apprentice** program.

Houdini Apprentice contains virtually all of Houdini FX's features with only a few limitations. It uses a special non-commercial file format (.hipnc) and you can share files between all of these versions.

**Houdini Apprentice** – This free version of Houdini Apprentice renders with a small unobtrusive render watermark and has a limited render resolution of 720x576. It can be used for learning or to create demo reel content.

**Houdini Apprentice HD** – Houdini Apprentice HD removes the watermark and raises the resolution to 1920x1080 for animations and unlimited for stills.

**Houdini FX Education** – This is a full version of Houdini FX complete with Mantra and batch tokens. It also uses the .hipnc file format so that students can work on projects at home using Apprentice.

### SELECTED FILMOGRAPHY

Houdini has been used by many of the top VFX studios to create CG for feature films. Here is a selected list of movies which include work created in Houdini:

- Avatar
- Iron Man 2
- Prince of Persia
- 2012
- G.I. Joe: The Rise of Cobra
- Terminator Salvation
- Up
- Cloudy with a Chance of Meatballs
- Monsters vs. Aliens
- Coraline
- Watchmen
- The Dark Knight
- Wall-E
- Transformers
- The Curious Case of Benjamin Button
- The Pirates of the Caribbean: At World's End
- Superman Returns
- The Wild
- X-Men: The Last Stand
- Spider-Man trilogy
- Harry Potter series
- Lord of the Rings trilogy
- Matrix trilogy
- and more...

3

## Going Procedural

On a daily basis, digital artists, like yourself, are being asked to create more shots and achieve more realistic results with tighter deadlines and shrinking resources.

To handle the workload and keep focused on the creative process, going procedural with Houdini will benefit you a great deal in production.

Houdini offers you flexibility and control which enhance the way you work creatively and make you and your team much more productive.

In Houdini, everything is procedural which means that modeling, character rigging, lighting, rendering and visual effects all benefit from this approach. In Houdini, each procedural network offers a collection of nodes which connect together to describe the steps needed to accomplish a task.

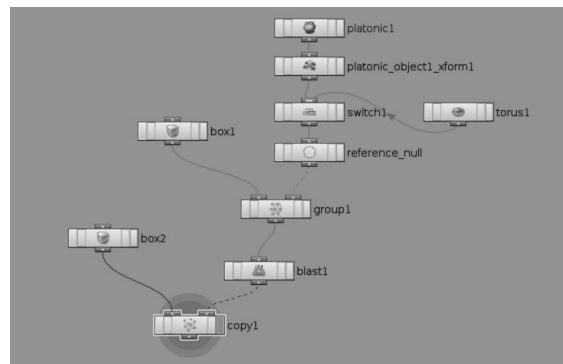


Visual effects artists have traditionally gravitated to Houdini because this procedural workflow is ideal for creating effects with particles and dynamics. For other parts of the pipeline, going procedural has additional benefits which can be used by studios who want higher levels of productivity and by artists who want more control over the creative process.

### NODE-BASED WORKFLOW

In Houdini, every action is stored in a node. Going procedural is as easy as placing and connecting, or “wiring” these nodes into networks which give you access to the complete construction history of a scene.

You can then use tools to add to the network or work directly with the nodes to manage the results. You can add nodes, delete nodes, by-pass nodes, and comment nodes. You can also copy and paste nodes or networks between projects.



You can even create nodes that contain other networks inside them then share these custom nodes with colleagues. Instead of creating external scripts and pipeline tools to manage your work, the networks give you a pipeline right inside Houdini.

### RAPID PROTOTYPING AND REUSABILITY

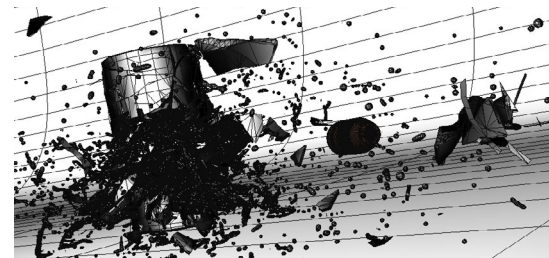
Using Houdini’s procedural approach, artists can quickly prototype a shot using low-resolution geometry then swap-in a detailed model for final output. Because the network acts like a pipeline, the same network can be used in different shots and even different projects while only minor variations are needed to produce unique results specific to each situation.

Houdini also makes it easy to share your tools without writing any code. Houdini’s re-usable networks can be wrapped up quickly and easily into new nodes called **Houdini Digital Assets**. Whether you are packaging up a visual effect, a character or a light rig, Digital Assets let you hide the network then promote key parameters to build an artist friendly interface.

These assets are, in essence, artist-built plug-ins and can be put into production like any other tool. With artists and technical directors building day-to-day tools this way, on-site programmers can focus on much more challenging technical issues.

### MANAGING COMPLEXITY AND SCALABILITY

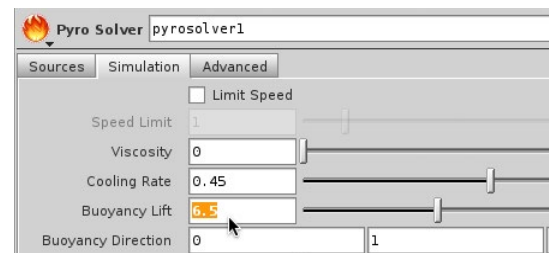
In a typical CG shot, there are lots of steps involved which can result in large networks of nodes. Other 3D applications generally avoid construction history or tell you to delete it because their architecture would simply bog down as shots get bigger.



Houdini’s node-based approach is designed to minimize and handle complexity and provides you with many tools for organizing and managing the networks. Instead of deleting history, you learn to use it to your advantage and make it an integral part of your production process.

### REVISE DEEP INTO PRODUCTION

By going procedural, all the steps needed to set up a shot are represented by the node networks. Making changes to any of these nodes will cascade right through the network to update your shot. This directability can be retained deep into production and can be used to make last minute creative decisions that would be too costly in a traditional CG pipeline.

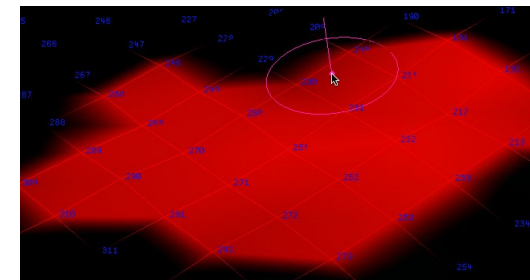


In this way, Houdini lets you easily respond to director feedback by simply inserting an updated asset into the pipeline. Houdini Digital Assets also benefit from a robust referencing system which lets TDs and supervisors manage the assets behind the scenes while artists focus on creating.

This version-less approach to managing assets simplifies inter-studio communication and makes sure that costly mistakes are not made.

### DATA ACCESSIBILITY

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 manage it behind the scenes, Houdini gives you many tools for working with and managing this data. This results in a much more powerful and flexible approach that can make a huge difference when working in production.



This data flow can be especially effective with objects that are animated over time. As a piece of geometry moves and deforms, a procedural network can work with this motion and react accordingly. For this reason, Houdini is a great tool for making sure that effects such as dust, debris, fur, and feathers respond to objects in your shot. By keeping the flow of data “live,” animation can be revised and the effects will update automatically. This reduces the manual labor needed to address these kind of changes which in turn saves you money.

**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 lots of code in other 3D animation applications.

Houdini is very much an artists tool and while it also 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.

**Q&A**

# Houdini in the Pipeline

Computer animation and visual effects projects involve a number of steps such as modeling, rendering, animation, particles and dynamics. Here are some of the ways in which Houdini can help you in these different areas of the pipeline.

## PIPELINE DIAGRAM

This diagram shows how all of the Houdini products fit into a typical CG pipeline.

While Houdini FX can be used for all stages, many parts of the pipeline are a better fit for Houdini's more affordable feature set.

As you learn more about Houdini's procedural approach, you will discover the many benefits it offers for CG artists working in production. Whether you are working on your own, with a small team of artists or a studio with hundreds, a procedural approach creates a clean flow of data which supports the exploration of ideas and changes made by the director.

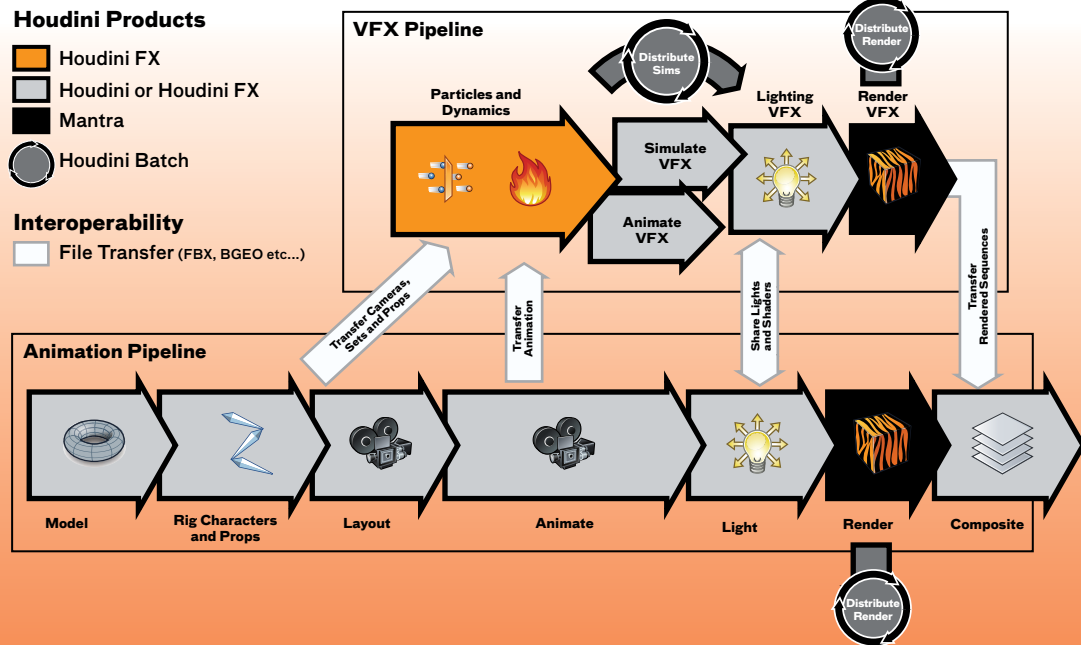
Houdini is best known as a visual effects package, although it has been used by some studios for all parts of the pipeline. To help you map out the possibilities, the following diagram outlines all the different areas where Houdini can be used.

The production pipeline mapped out here offers a generic picture which might apply to a large pipeline used by a big studio or a simple pipeline used by a smaller team. This is because Houdini's procedural approach offers a viable pipeline solution for individual artists which scales very well no matter how big your team grows.

Of course, the steps shown here would change depending on whether you are creating visual effects, CG animations, commercials or videos games. In general though, these pipelines share certain common threads which are represented by the steps as outlined. Any differences are easily accounted for in Houdini as you customize your workflow to suit the particular needs of your project.

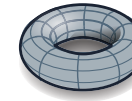
Houdini can play an important role in a larger pipeline because it has the ability to open up scenes created in Houdini FX allowing you to animate, light and render the existing nodes.

If visual effects in Houdini FX are packaged up as Digital Assets then you can even have junior FX artists using them to finish up shots in base Houdini. You can also exchange files with other apps using formats such as FBX. This ability to pick the right tool for the right job makes a Houdini-based pipeline an effective solution.



## MODELING

Houdini's modeling tools can be used to create characters, sets and props or by visual effects artists to give particles and fluids shape and form, fracture solids, instance geometry and more.



For traditional modelers, Houdini provides a set of tools that work with a wide variety of geometry types. For visual effects artists, Houdini's node-based workflow makes it easy to set up complex environments or surfaces that are generated on the fly in reaction to an underlying effect.

**Construction History** - As you work, Houdini's node-based workflow keeps track of all your modeling actions. Houdini efficiently manages the nodes to make sure you are not bogged down as you work. This lets you freely revise parameters on your nodes, branch off to explore new ideas or set up switch nodes to compare topologies.

**Build Environments** - To model CG environments piece by piece can be a daunting task for a modeler. With Houdini, you can set up procedural networks that build environments out of a smaller kit of parts. Once the system is in place, you can easily add randomness, paint specific features such as height and scale, and eventually grow the solution to any size.

**Clean Geometry** - Building a model is one thing. Building a model that animates and renders properly is a different matter altogether. Houdini give you low-level access to every aspect of your geometry and provides procedural techniques for making your geometry production-ready.

*Modeling tools are available in: Houdini and Houdini FX.*

## ANIMATION

Whether you are bringing characters to life or creating high-powered visual effects, the ability to freely animate anything and everything is critical.



Houdini not only lets you animate any parameter, but with transition nodes such as switch and blend you can easily animate back and forth between completely different networks. The resulting motion can then be processed through Houdini's procedural motion editing system called CHOPs for even greater control.

**Animator-Friendly Workflow** - Animators can easily set keyframes on selected objects then edit the results in either the timeline, channel editor or dope sheet. Channel groups can be created and pinned to make it easy to set many keyframes on multiple parameters to block out motion. Houdini has other animator-friendly tools such as Heads up display (HUD) handles that provide quick access to key parameters.

**Flipbook Blocking** - Houdini's flipbook can be set up to only play back frames where your character has been keyframed. The flipbook plays back in real-time and holds the frames based on their proper timing. Animators can then quickly move the frames around in the flipbook to adjust the timing then export the results back into the 3D scene. A real time-saver on the production floor.

**Advanced Motion-Editing Tools** - Houdini's procedural motion editing environment called CHOPs lets you either build up motion using a node-based workflow or import keyframed motion, run it through motion filters, then send the results back to its original parameters. Get quick access to these tools using the Motion FX menu to discover a completely new way of manipulating motion-data.

*Animation tools are available in: Houdini and Houdini FX.*



**Bolex**  
Lisa Kelly



**The Wire Man**  
Mark Wainwright



Sea Dragon  
Sergio Cairas



Lighthouse  
Steve Tucker

## CHARACTER RIGGING

From cartoon characters that squash and stretch to hyper-realistic digital creatures, character rigs continue to get more and more sophisticated to meet the growing expectations of audiences. Houdini provides a robust character solution that can be used as part of a visual effect or as a larger animation pipeline.

Houdini's node-based approach fits perfectly with working methodology of a typical rigging Technical Director without relying on lots of scripting.

- **Digital Assets** - Characters in Houdini are created as Digital Assets that encapsulate all the bones, geometry, deformations, facial poses and even materials. You can then reliably reference your characters into multiple scenes and seamlessly edit and update them as needed.
- **Production-Ready Auto Rig Tools** - Created by animators, the Auto Rig tools make it easy to rig up any character. Set up an animation rig in less than an hour with proxy geometry and start animating right away. Then capture your actual surface to a separate deform rig that can be plugged in once you have painted capture weights. Biped and quadruped setups are ready to go out-of-the-box while custom auto rigs can be quickly built using a wide variety of both human and animal body parts.
- **Interactive Muscles And Skin** - Adding realistic muscles and skin to your characters has never been easier. Build up your underlying musculature using metaball-based tools then capture the metaballs to drive the character's skin. This unique system provides interactive feedback that does not require simulation even for systems built using jiggle and skin sliding.

Character rigging tools are available in:  
*Houdini and Houdini FX.*



## PARTICLES

From dust to debris to flocks of birds, particles offer a strong foundation on which you can build any effect. Houdini is famous for its node-based particle workflow that lets you define a set of rules using interactive tools.

- **Total Control** - To build up complex particle systems, Houdini gives you access to a rules-based approach that offers unlimited control. Define the behavior of the system for each individual particle using a network of nodes that set up a series of operations and conditions. By defining the rules, you can create particle simulations that behave the way you need them to no matter how many particles are involved.
- **Full Integration** - The most impressive particle effects involve interaction with the other parts of your scene. In Houdini, particles can react to and influence geometry, dynamics, and even materials. This creates a shot that is alive with interconnections that would be impossible to manage with keyframes alone.
- **Rendering Particles** - While particles are just points in space, their final rendered look will be quite different. From sprites to volumetrics to instanced geometry, there are a number of ways in Houdini for you to make your particles more realistic.

Particle tools are available in:  
*Houdini FX.*



## DYNAMICS

Create realistic motion that meets the creative needs of your director using Houdini's integrated dynamics tools. Houdini's dynamics architecture lets different solvers talk to each other, so you can simulate using any combination of Rigid Body, Fluid, Cloth and Wire solvers to create boundary-busting effects.



- **Solvers That Work Together** - When working with dynamics, it is critical that you can control both what goes into a simulation and what comes out. Rigid Body, Fluid, Cloth and Wire dynamics all work together to create highly sophisticated simulations that you can easily integrate into your existing effects pipeline.
- **Fire, Smoke And Water** - To create natural looking fluid effects, you can work with volume-based or particle-based fluid simulations in Houdini. Apply a variety of forces such as surface tension, viscosity, visco-elasticity, vortices and fuel to control the results. Particle fluids can be surfaced at the geometry level to produce high quality splashes.
- **Smashing and Tearing** - Houdini's Rigid Body Dynamics solver lets you create highly complex simulations of large data sets. The solver works with various forces, constraints and collisions and gives you complete control over all aspects of the simulation. A unique and powerful feature is Houdini's Voronoi-based dynamic fracturing tools which will break up a model based on the impacts which occur during a simulation.
- **Distributed Fluid Sims** - Unique slicing of simulations to distribute calculations on the farm. These sims are also fully multi-threaded.

Dynamic tools are available in:  
*Houdini FX.*

## LIGHTING

Houdini's lighting workflow provides a flexible and powerful environment for managing lights, building shaders and defining the look of a shot. Light and material shaders are created using Houdini's procedural node-based shader builder featuring dozens of shader operations.



- **Control Lights Across Many Shots** - Senior lighters can set up lighting for a family of shots then bundle them up into light rigs that are distributed as Houdini Digital Assets. This ensures that each shot has a common starting point while parameters can be tweaked on a shot by shot basis to perfect the look.
- **Material Palette** - Houdini now includes a material workflow that begins in the Material Palette where you have access to a rich gallery of materials which can be applied as is or edited using the shader builder. To create different looks for your objects, you can override material properties on a per object basis.
- **Building Shaders and Materials** - Whether you use Houdini's Mantra renderer or RenderMan, shaders can be created using the interactive shader builder. Connect nodes to define the look of the shader then bundle up one or more shaders into Materials. You can even set up both Mantra and RenderMan shaders in a material then use a switch node to trigger when the appropriate renderer is used.

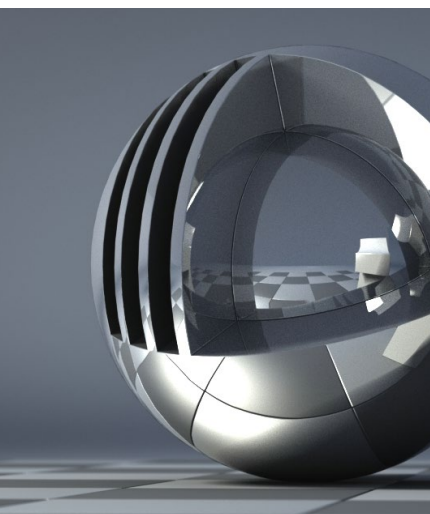
Lighting tools are available in:  
*Houdini and Houdini FX.*



Rocket  
Keith Acheson



Smashup  
James Roberts



Chrome  
James Roberts



Pororoca  
Scott Pagano

## RENDERING

At the back-end of any CG project is where you render all your lights, geometry, and effects. With Houdini, you can rely on a robust built-in rendering solution called Mantra or full support for a wide variety of third party renderers. Whatever route you choose, Houdini is the ideal environment for bringing together your render layers and reliably feeding the farm.

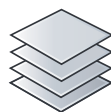


- **Mantra** - More and more studios are discovering the performance benefits of a Mantra render pipeline. With a strong shading language behind it and the ability to choose between micropolygon, raytracing or physically-based rendering, you will quickly learn how Mantra can benefit you. Unlimited Mantra tokens with either Houdini or Houdini FX makes this an even more attractive option.
- **RenderMan Support** - With Houdini, you will enjoy a tightly integrated interface to Pixar's RenderMan® and RenderMan compliant renderer such as 3Delight which includes a node-based RenderMan shader builder and support for test renders in the 3D scene view.
- **All Renderers Welcome** - Houdini also provides integrated support for other third party renderers such as mental ray™ and Maxwell™. With Houdini's new Python support, you can easily write your own hooks for whichever renderer you prefer.

*Rendering tools are available in:  
Houdini and Houdini FX.*

## COMPOSITING

While you likely rely on an existing team of compositors to layer effects onto live action plates or tweak render passes, it does not hurt to do a little compositing as part of the lighting and rendering of your shots. With node-based compositors offering the most robust solution when working in production, Houdini's approach carries over well to this area of production.



- **Render Pass Support** - When you render different passes, you need a quick way of verifying that everything worked out fine. Houdini lets you link together render output nodes with compositing output nodes that render together as a network. This gives you both your individual passes and the final composite with the click of a button.
- **Perfect for Lighters** - To speed up the decision-making process as you light a shot, you can choose to render out high dynamic range images and set light contributions in the compositor. This is a much more interactive process and it makes it easier to involve a director in this critical phase of a project. If you render out surface normal information you can also set up new lights in the compositor without re-rendering the shot.
- **Production-ready** - The compositing tools are fully multi-threaded and built on a modern tile-based architecture boosted by access to the GPU.

*Compositing tools are available in:  
Houdini and Houdini FX.*

## SCRIPTING

Scripting and programming can play an important role in setting up advanced production pipelines and tools. With Houdini's node-based workflow and Digital Asset technology, many tasks normally reserved for the programming team can now be handled by artists. Beyond that there are a number of robust scripting and programming tools available in Houdini with Python playing a key role.



- **HScript Expressions** - Houdini's own expression language used to create channels references and write simple expressions. In many cases this work can be handled more efficiently with Python.
- **Integrated Python Support** - Houdini includes an object-oriented Python API which provides low-level access to everything you need to script. Easily integrate Houdini into your existing pipeline with full access to Python libraries and build custom UI widgets that work directly in Houdini.
- **The Power Of VEX** - VEX is a high performance parallel language for processing large amounts of data. With a syntax similar to C, VEX is easy to learn for anyone with a coding background. VEX is used to write custom nodes for Houdini and to create shaders. Houdini includes a node-based interface for creating VEX code.
- **FREE Houdini Development Kit** - The HDK is a C++ toolkit for developing plugins for Houdini and Mantra that gives you access to the same interface to Houdini that Side Effects Developers use. You can even use the HDK if you work with Houdini Apprentice.

*Scripting tools are available in:  
Houdini and Houdini FX.*

## INTEROPERABILITY

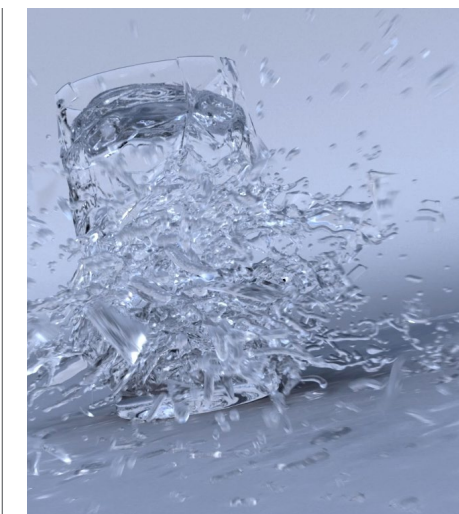
If you are already working in an established pipeline then you may want to model, animate or light your shot in another application. In these cases, you can pass data from those apps back and forth to Houdini using exchange formats such as FBX.



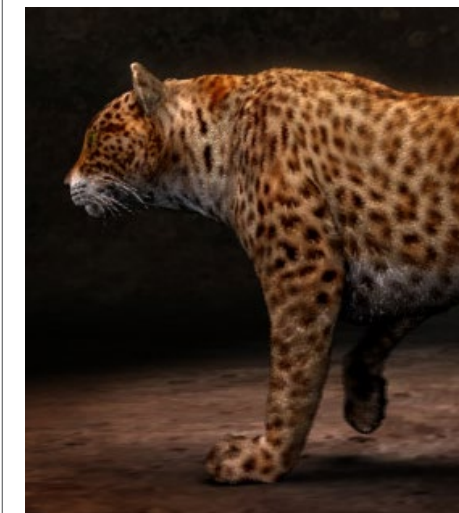
Even in an all Houdini-based pipeline, geometry files are often saved out at the end of one stage then referenced into the next. This works well since Houdini can keep a live connection to the file on disk and update quickly when those files are changed.

- **Geometry** - Houdini has a built-in geometry format called .bgeo which support geometry sequences, point data and more. Houdini is also part of the open source Alembic initiative being developed by Sony Pictures Imageworks and ILM which is also about outputting geometry files.
- **FBX** - This interchange format gives you a method for exchanging whole scenes including rigging info, lights, cameras and more. You can import and export to this format from within Houdini.
- **Collada** - Originally a game-focused solution, Houdini can import files using this format.
- **OpenEXR** - Rendered images with multiple channels can be exported to this format for using in a compositor. This format is another open source project sponsored by ILM.

*Interoperability tools are available in:  
Houdini and Houdini FX.*



Shatter  
Steve Tucker



Leopard  
Keith Acheson



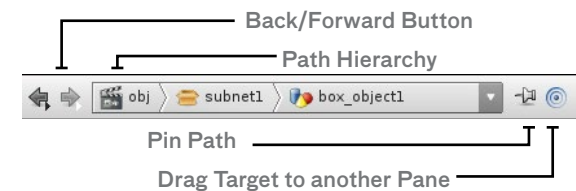
# Nodes and Networks

With Houdini's node-based workflow at the heart of its procedural approach, the ability to work with these nodes and networks becomes very important to using it effectively. Luckily there are lots of artist friendly tools for building up and managing nodes.

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 use this flow of information to make changes and refine your work. While it is possible to focus all your effort on the scene view, learning how to work effectively with the node networks will give you more flexibility in production.

## 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.



You can use this path to navigate up and down this hierarchy or to other networks you have been working

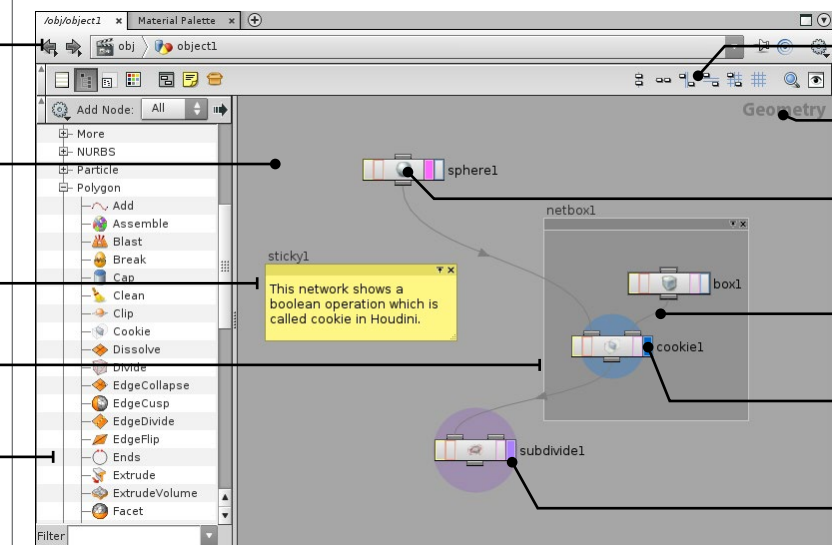
**Network Path** - The path leading to the current network level is displayed here. You can also use this bar to navigate to other networks.

**Network Background** - You can add an image or set up a grid to help you organize your nodes.

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

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

**Node Gallery** - Drag these nodes over to add them to your network. Use the filter at the bottom to quickly find the node you need.



with. 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 another pane to change its path.

## NETWORK TYPES

Houdini includes different kinds of nodes which each work in their own context. The network type is highlighted in the network view and can be used to determine where you are in Houdini.

■ <b>Scene</b>	<b>Objects</b>	<b>OBJ</b>
■ <b>Geometry</b>	<b>Surface Operators</b>	<b>SOPs</b>
■ <b>Shaders</b>	<b>Shader Operators</b>	<b>SHOPs</b>
■ <b>Motion</b>	<b>Channel Operators</b>	<b>CHOPs</b>
■ <b>VEX Builder</b>	<b>VEX Operators</b>	<b>VOPs</b>
■ <b>Render Outputs</b>	<b>Render Operators</b>	<b>ROPs</b>
■ <b>Particles</b>	<b>Particle Operators</b>	<b>POPs</b>
■ <b>Dynamics</b>	<b>Dynamic Operators</b>	<b>DOPs</b>
■ <b>Compositing</b>	<b>Compositing Operators</b>	<b>COPs</b>

While the different types of nodes are similar in how they are wired together, they each have unique capabilities which can affect how they can be used. It is important to learn how each one works.

**Align Tools** - These tools let you organize the look of your network.

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

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

**Connector** - The connecting lines show how your nodes are linked together and how the data is flowing.

**Display Flag** - This flag and the small circle show which node is displayed in the Scene view.

**Render Flag** - This flag and the large circle indicate a render node even if another node is displayed.

If you encounter a seasoned Houdini user, you will often hear them talk of POPs, SOPs and DOPs. As you can see, each of these refers to a specific network type and has become the secret language of Houdini users around the world.

## 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 can get you to another network 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 the network path to go back up the path or **RMB-click** to access other parallel networks.

**Hotkeys** - Here are a few hotkeys which help you navigate up and down as you work with objects. These hotkeys work with selected nodes.

- Dive in
- Jump up
- Go to Geometry

i  
u  
F8

**Jump to Menu** - If you **RMB-click** on geometry, then you can use the **Jump to** submenu to go to networks which contain nodes related to the geometry. This could be a material, particle network or dynamic network.

## WORKING IN THE NETWORK EDITOR

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.

- Select Nodes
- Pan
- Zoom

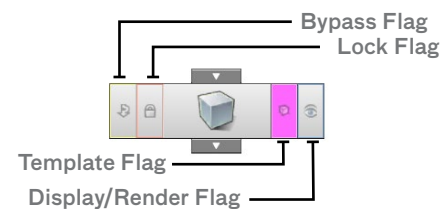
LMB  
MMB  
RMB

Here are some other ways of interacting with nodes and connections in the network pane.

- **Connect Node** LMB on output then on input
- **Insert Node** LMB drag onto connector
- **Disconnect Node** LMB then Jiggle node
- **Disconnect Node** RMB-menu on connector

## NODE FLAGS

Each of the nodes seen in the network view have various flags which determine if it is displayed, locked or bypassed. You will work with these flags as you manage your networks.



**Display Flag** - The display flag offers a way for you to choose which node in your network is used as the output for that network.

**Render Flag** - This flag sets which node will be output for rendering. You can set this separately from the Display flag by **Alt[opt]-clicking** on the Display flag.

**Bypass Flag** - This flag means that this node is ignored when the network is cooked.

**Lock Flag** - This caches a network at the locked node and all changes to nodes earlier in the chain are ignored when the network is cooked.

## 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 has all the nodes.

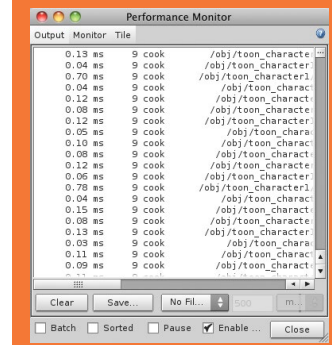
You can create your own galleries using the **Windows > Gallery Manager** and you can add items to your galleries by **RMB-clicking** on a node then choosing **Save to Gallery...**

## WHAT DOES IT MEAN TO COOK NODES IN HOUDINI?

The cooking of a node refers to the flow of data through a network and the various calculations needed to show the final output.

Houdini is very smart about when it cooks a network, making it possible for you to keep the nodes around as you work. When the results of a network are being displayed Houdini looks for "dirty" nodes then re-cooks. Otherwise the network doesn't re-cook and you can move ahead more quickly.

You can also select **Windows > Performance Monitor** to bring up a window which lets you evaluate the cooking of your networks and then figure out which nodes are slowing you down. You can then change your network and explore ways of making things go faster.





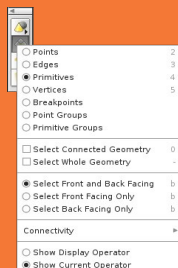
# Select and Transform

Interacting with 3D scenes involves the selection and manipulation of many different elements. You should therefore become familiar with how Houdini's selection and transform tools work.

In Houdini, you can either select objects, faces and points in the scene view or the node view, then make adjustments using handles.

## SELECTION MODE OPTIONS

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.



One of the first things an artist does when faced with a new application is to dive into the software. One of the first question which arises is to "how do I select and edit objects." In the case of 3D geometry, this often brings up the question of "how do I transform objects," then "how do I select points and faces to begin reshaping the object."

Houdini has a number of different ways of making selections in the scene view that work with objects, geometry, particles and dynamics. Another way of working is to select nodes which can also give you access to handles and allow you to edit your scene. Both approaches work well and offer you different ways of getting the job done.

You will sometimes want to select and work with objects while other times you will want to dive in and work with the underlying networks of nodes. As much as possible, you will want to make these selections in the Scene view.

## SELECT TOOL

The select tool lets you focus on making selections therefore it doesn't have any manipulation handles. You can use the selection modes to decide what you want to select then pick away in the Scene view.

- **Select** s

## TRANSFORM TOOLS

The transform tools give you handles that you can use to manipulate objects or reshape geometry. You can also make new selections while using these tools then continue to transform using the new selection.

- **Move** t
- **Rotate** r
- **Scale** e

When you transform objects, the parameters at the object level are updated to reflect your changes. If you have geometry selected then an **Edit node** is placed down to accept your transformations. In both cases, you can focus on the Scene view and the handle manipulations will change the parameters.

## SELECTION MODES

By using selection modes, you can access geometry, particles and dynamics and your network will jump to the appropriate location without you navigating the node hierarchies.

**Objects** - The object network level is where you work with an object's transforms. By default all object types are selectable but you can filter down the list by **RMB-clicking** on the **Selection Mode** icon.

If you are using the **Select, Move, Rotate, Scale** or **Handles** tools, the following hotkey will bring you back to the Object level:

- **Objects** 1

**Geometry** - You can use any of the following hotkeys to jump into geometry mode with the chosen components available for selection.

- **Points** 2
- **Edges** 3
- **Faces** 4
- **Vertices** 5

Only one of the geometry selection modes can be active at a time. You can use these to select specific parts of your geometry then use modeling tools to edit its shape. **Important:** these hotkeys do not work when you are in the View tool.

To jump up and down from the Object to Geometry levels, you can also use the following hotkeys. These work with your selected objects and take you to whichever geometry type was last used.

- **Toggle Objects/Geometry** F8
- **Dive into the Geometry level** i
- **Dive back up to the Object level** u

**Particles and Dynamics** - These selection modes let you find Objects and points that are part of a simulated effect. When you select the item in question then unpinned networks will jump to the selected network level.

- **Particles** 6
- **Dynamics** 7

## HANDLE TOOL

When you are working with nodes that are not at the object level, you will want to work with the specific handles associated with that node. This is where the Handle tool comes in. It looks at the currently selected node and makes the appropriate handles appear.

- **Handle** Enter

After using a tool from the tool shelf, you often end up in the Handle tool where you can work interactively using the provided handle.

## VIEW TOOL

If you want to evaluate your geometry quickly without losing your current selection then you can go into the View tool. This will take away any selection highlights and let you visualize the results. When you return to one of the other tools then your selection will appear highlighted on the geometry.

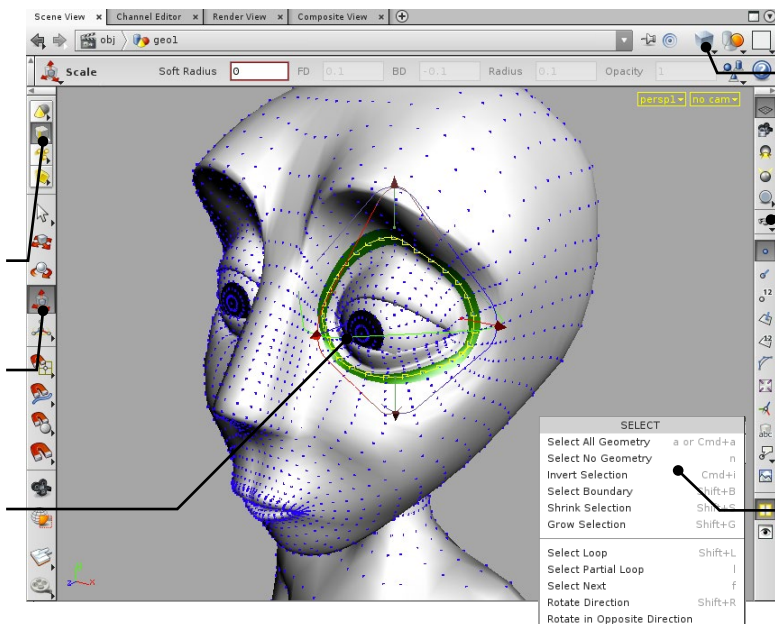
- **View** Escape

**SELECTIONS** - Making selections and transforming is a workflow you will perform on a regular basis in the Scene view. Here are the main tools you will use as you work interactively.

**Edge Selection** - In this image, edge selection has been used to get an edge loop around the character's eye. If you were to change to point selection then the selection would convert.

**Scale Tool** - The Scale tools is being use to manipulate the selection. You will work with the handle in the view.

**Handle** - This handle lets you scale in all axes using the arrows, two axes using the outer edges and one axis using the lines under the arrows. **RMB-click** on the Handle to access the handle options.

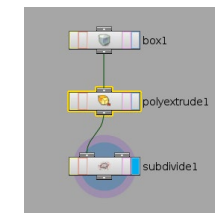
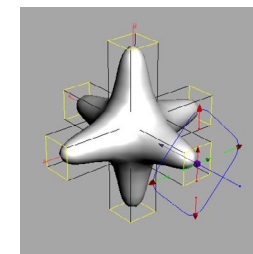


## SELECTING NODES

Nodes play an important role in organizing and building up a 3D scene in Houdini. They provide artists with a look "under-the-hood" and can be used to organize and manage a scene. They also offer a quick way to select a specific part of an objects history and make changes in the Parameter pane.

Once you have a node selected, you can press the **Enter** key in the Scene view to go into the **Handle** tool which will bring up a handle to let you adjust certain parameters for the selected node. Other parameters can be changed in the Parameter pane as long as the node is selected.

In geometry networks, when you select a node in the chain that is not the display node, you get a wireframe display of the geometry at that point. You can then use the handle to manipulate this intermediate node. In addition, the Select tool will let you select from the intermediate node, and any tools you apply will insert a node at that point in the chain.



In this network, the **Handle tool** uses the *polyextrude1* node's handle and shows a wireframe of what the model looks like at that stage while the subdivided geometry is shaded.

**Shading Options** - The shading options determine what you see in the Scene view. In this case, the geometry uses basic shading.

**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.

**Display Options** - While the selection modes show you edges or points when you have nothing selected, you need to turn on Display options if you want to see these all the time.

**RMB-Menu** - This menu gives you access to selection options such as edge loops or growing and shrinking your selection.

# Time and Motion

Animation involves changes happening over time. Whether we are talking about the position of an object or its overall shape, if moving forward in time creates a visible change then you have yourself an animation.

Houdini has all the key tools for a keyframe-based workflow in addition to a procedural node-based workflow called **CHOPs** for more advanced manipulation of time and motion.

## THE TIMELINE

At the bottom of Houdini's main workspace is the Timeline which lets you see your frame range and set your current time. Houdini measures time in frames with a default frame rate of 24 frames per second. The Timeline can also be used to edit keyframes.

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 Scoped Key Ctrl + →
- Previous Scoped Key Ctrl + ←

You can also **RMB-click** on the frame range in the timeline 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 Timeline before moving to the Channel editor.

## SETTING KEYFRAMES

To animate, keyframes are set whenever you want to set a specific parameter value at a specific point in time. As these keyframe values change, the objects in your scene will become animated. You can then define animation channels to create the in-between shape for each animation curve.

**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 timeline.

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

**Edit Keys** - As you set keys, your scoped channels are shown in the timeline. Press the **shift** key to select keys with the **LMB** and then edit the keys with the **MMB**.

**Auto Key** - The Auto Key button will automatically set keyframes when you change a parameter value. This works well for a straight-ahead animation style.



**Playback Controls** - These controls let you quickly play, pause, and move to next key.

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 **RMB-clicking** on a parameter and selecting **Channels and Keyframes > Set Keyframe**. This lets you set keyframes one parameter at a time.

## SCOPED CHANNELS

When you set a keyframe or look at animation curves in the channel editor, you are generally working with what are called **scoped channels** with a channel being another name for a parameter. While the scoping process happens automatically as you work, it is useful to understand it as you begin animating.

If you select an object then its channels are scoped and any existing keyframes loaded into the timeline or channel editor. If there aren't any keys then the channels wait for you to press the **k** key.

The **Channel List** can be used to keep tabs on which channels are currently scoped. You can set up channel groups which offers another way of scoping channels and lets you pin down groups of channels so that they stay scoped even if you deselect an object. You will want this pane visible if you are setting keys.

## THE CHANNEL EDITOR

Scoped channels are loaded into the channel editor where they are represented as keyframes and animation curves. 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 change which keys you are viewing using these hotkeys:

- Pan Spacebar - MMB
- Zoom Spacebar - RMB

## FLIPBOOK PREVIEWS

As you animate your scene, you will want to preview the results. 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.

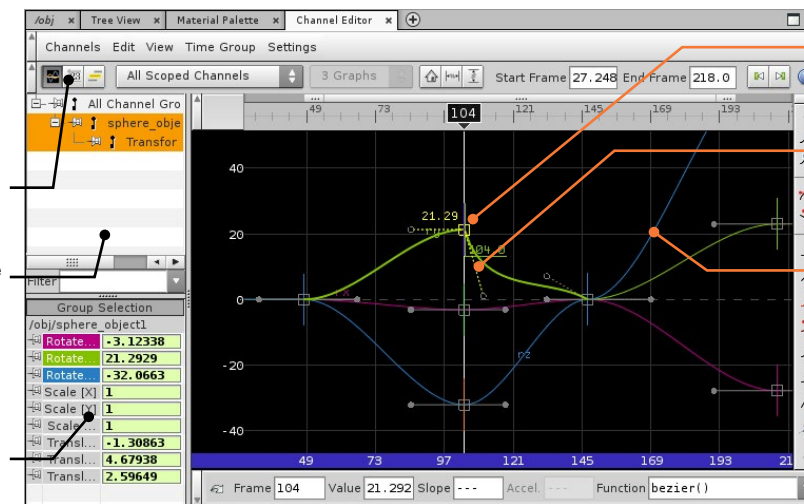
You can also use **Flipbook blocking** to capture only frames that have keyframes set, then watch the frames play back with the proper timing. You can then edit the timing of the frames right in the Flipbook.

**CHANNEL EDITOR** - This panel is where you refine your animation channels and work directly with keyframes and curves.

**Editor Options** - This editor can be shown as a graph, a dope sheet or a table. You can choose the type of editor which is most appropriate.

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

**Scoped Channels** - Channels that have been scoped show up in this area. You can then select the names of channels you want to see in the graph.



## CHANNEL OPERATORS AND 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 complete node-based approach to working with motion.

The easiest way to create a channel operator is using **Motion FX** which can be found when you **RMB-click** on a parameter and select from the **Motion Effects** sub-menu. You can also apply these effects to channel groups using the Channel List or the Timeline.

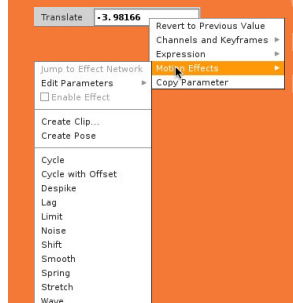
Motion FX can be applied to keyframed motion which is extracted and stored in a **Channel CHOP**. You can then apply effects such as cycle, noise, smooth, limit or lag to the existing motion.

These effects are added using procedural nodes and offer a lot of flexibility as you refine your solution. On the **Animation** shelf, you have tools which let you have one parameter either lag or jiggle behind another.

This non-linear approach to working with motion offers a different way of working that can be very flexible and powerful in production.

## ACCESSING MOTION FX

The Motion FX menu is available when you **RMB-click** on a parameter. This will assign a CHOP to that parameter then show you the motion view and a floating parameter pane for you to edit the node.



**Selected Key** - Move the key in time using the vertical bar and edit its value using the box.

**Tangent Handles** - They define the tangents coming in and out of a keyframe and they help you shape the surrounding animation curves.

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

**Curve Functions** - They let you change the shape of the in-between curves and can determine if you are speeding up or slowing down.

# Lighting and Rendering

Lighting and rendering a shot involves setting up light sources, cameras and surface materials to create a specific look which captures the mood of a shot.

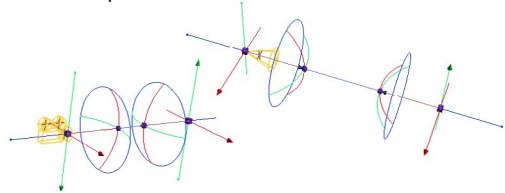
In Houdini, you will employ a wide range of skills to create a well lit shot and here are some of the tools you will be working with.

Houdini offers a great framework for lighting and rendering your shots whether you use Houdini's built-in renderer **Mantra** or any number of third party renderers such as **RenderMan**. You can even mix and match renderers within the same scene and render out different passes with the look you want.

## LIGHTS AND CAMERAS

To render out your scene, lights and cameras play a key role. The camera defines the framing of your view while the lights define its mood and character.

**Creating** - At the top of the workspace, you will find the **Light and Camera** shelf which contains a variety of different light types and cameras including a stereoscopic camera.



**Positioning** - You can manipulate handles belonging to lights/cameras or you can look through the lights/cameras, **Lock Camera/Light to View** and then use Tumble, Track and Dolly to update their position.

## MATERIALS

Materials contain the shading information needed to determine how an object will react to light in your scene. Materials can use properties such as diffuse, reflection and bump. You can also texture map materials for even more surface detail.

**Palette** - The palette shows all your materials no matter where they are in your scene hierarchy. There is also a gallery for creating new materials.

**VOPs** - VEX operators let you build shaders using an interactive node-based interface. The Shader FX menu beside each parameter in VOPs, makes it even easier to create and connect these nodes.

**VEX** - A vector expression language used to create shader code and custom nodes. VOP nodes generate VEX code as you wire them together.

## RENDER OUTPUT NODES

Houdini has a dedicated context just for output nodes called Render Operators [ROPs]. In this context, you can set up these ROPs depending on whether you are rendering to Mantra, a third party renderer or to another format such as bgeo for geometry.

**Render Layers** - The Mantra ROP contains options for adding image planes to your final rendering. These can be used to break up a rendering into render layers on a per light basis. These extra channels can be stored as extra channels in OpenEXR files for use by the compositing team.

**ROP Dependencies** - Render Operators can be wired into networks with the data flow indicating render dependencies. For instance a Compositing ROP could be fed by Mantra ROPs which are in turn fed by Geometry ROPs. To render the Compositing ROP, the nodes feeding into it will need to be rendered first.

**Wedging**- The Wedge ROP lets you create multiple images or sequences using a range of values assigned to any parameter in your scene. This is great for quickly generating multiple iterations of your work.

## RENDERING WORKFLOW

There are a few different ways of rendering your scene in Houdini. Here are some of the key methods.

**Render View** - The Render View panel offers an interactive photorealistic rendering [IPR] environment which lets you rapidly tweak and refine your shot.

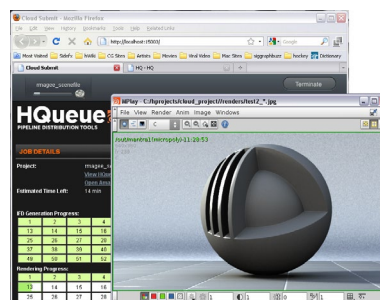
**Render to Mplay** - You can also send renderings to Houdini's Image Viewer called Mplay. You can then use the viewer to evaluate your work and export image sequences as movies.

**Render Region** - You can also use the Render Region tool in the scene view to drag a bounding box over your scene and render the chosen area. This is good for quick evaluations of lighting and shading.

## HQUEUE

HQueue is a Python-based job manager which can distribute Houdini jobs and Mantra renderings to local render farms. HQueue jobs can be launched using a ROP then monitored using HQueue's artist-friendly web interface.

The same HQueue technology is used by Houdini to connect artists to the **Amazon EC2 Compute Cloud** which provides access to a flexible system of render nodes for a reasonable hourly rate.



## COMPOSITING TOOLS FOR LIGHTERS

Houdini includes an environment for using Compositing operators [COPs] to build node-based compositing networks. The toolset includes color correction, rotoscoping and retiming tools and gives artists the tools to test out render layers and prepare output files for a compositing team which may be using an outside compositor.

## THIRD PARTY RENDERERS

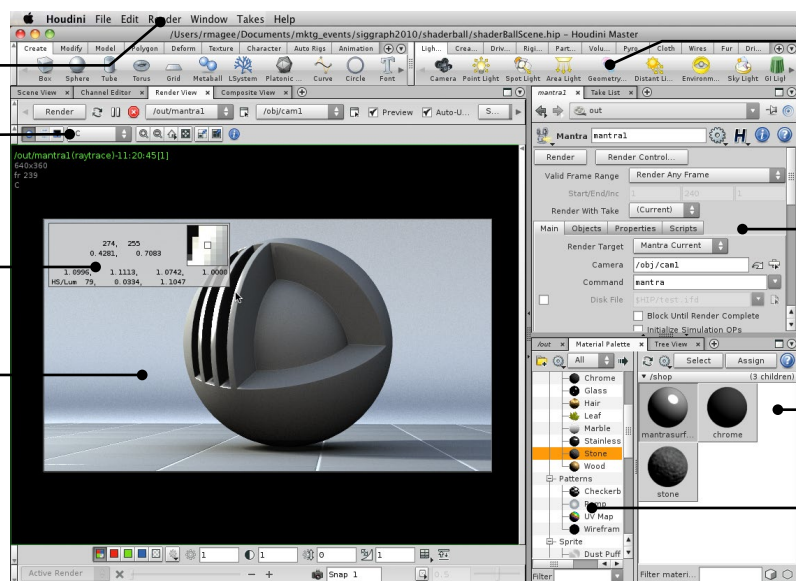
The lighting and rendering pipeline in Houdini works well with Mantra but can easily be adapted to other third party renderers. Pixar's RenderMan is well supported out of the box and other renderers can be integrated using Python to develop custom hooks. Once set up, you would use ROPs specific to your chosen renderer and can choose to mix and match these with Mantra ROPs as needed.

**Render Menu** - Go here to create render operators, start a render or set your render options.

**Channel Menu** - When you render deep raster files you can access the channels using this menu.

**Inspect Tool** - If you RMB-click in the render view you get access to special tools such as Inspect.

**Render View** - The Render view gives you an interactive photorealistic rendering [IPR] environment which lets you rapidly tweak and refine your shot.



**Lights and Cameras Shelf** - Go here to create lights and cameras. You can choose from point lights, spot lights, areas lights, environment lights and more.

**Mantra ROP** - This node contains all the parameters needed to define a Mantra rendering including multiple channels for setting up render layers. You can start a rendering from here or use the Render menu.

**Material Palette** - The palette is where you add materials to your scene then assign them to objects. Double-click on material icons to go to their VOP network.

**Material Gallery**- The gallery contains a library of pre-built materials which you can use right away.

## HOUDINI'S BUILT IN RENDERER

Houdini comes with a built-in renderer called **Mantra**. This production-proven solution offers you a renderer which is a hybrid of the RenderMan style rendering called Micropolygon and the newer Vray style rendering called Physically-based Rendering [PBR].

The new approach offers more realistic bounced light while the traditional style offers speed through features such as fast shadows and motion blur.

In Mantra you can combine these features within a single renderer. Mantra is also a very good solution for rendering volumes such as smoke or fire.



## VFX and Simulation

Houdini's node-based workflow offers an ideal environment for creating visual effects. From particles to rigid body and fluid dynamics, Houdini provides tools for every situation.

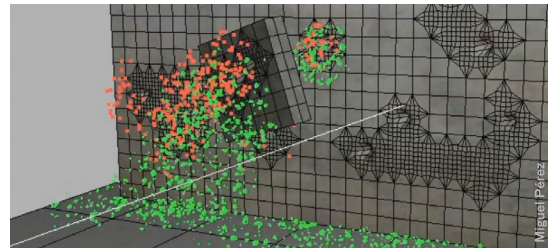
Houdini's strength in VFX is a result of not only strong particle and simulation tools but also a procedural approach which make your effects easy to control and thereby directable.

In production, this control and flexibility is critical and often makes a big difference when under a tight deadline.

A visual effect brings together modeling, animation, rendering and simulation into an integrated system of related events. You can easily choose from a wide range of VFX tools in Houdini or combine them to create even more sophisticated results.

### PARTICLES

Particles are points in space which are acted upon with forces. This gives them properties which have a natural feel, making them ideal for a number of different VFX. In Houdini, you control particles in the **Particle Operator** or **POPs** context.



### FLUID DYNAMICS

Liquids and gases exhibit specific behaviors which can be mimicked using fluid solvers in Houdini. These are found in the **Dynamic operator** or **DOPs** context and offer a number of approaches to fluid mechanics.



**Voxel Fluids** - Otherwise known as Grid-based fluids, this approach simulates your fluids inside a 3D container which applies a 3D resolution to the fluid calculations. The more you increase the resolution of the container, the more detail you will get in your sim.

You can create liquid, smoke and fire using this approach with fields such as heat, turbulence and dissipation defining how the fluid moves around the grid.



**Particle Fluids** - For liquids which require a more dynamic splashing effect, particle fluids using the FLIP solver are best. You can feed the results through a particle network for even more control.

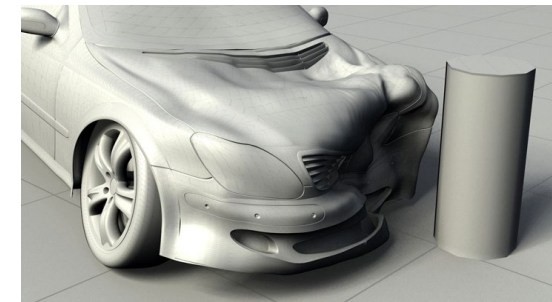
### RIGID BODY DYNAMICS

To simulate rigid objects bumping into each other or fracturing into tiny pieces, you can turn to Houdini's Rigid Body tools. With instancing tools and various constraints, this solver can be used to achieve a wide range of destruction shots as seen in many VFX shots.



### DUST, DEBRIS AND WHITECAPS

As you smash up objects or create dynamic fluid sims, you can use data from the sim to generate secondary effects such as dust debris or whitecaps.



### CLOTH DYNAMICS AND PLASTIC DEFORMATIONS

Houdini includes a cloth solver which is primarily used in Houdini for plastic deformations where an object bends and crushes on impact. You can also simulate tearing to show panels being ripped apart.

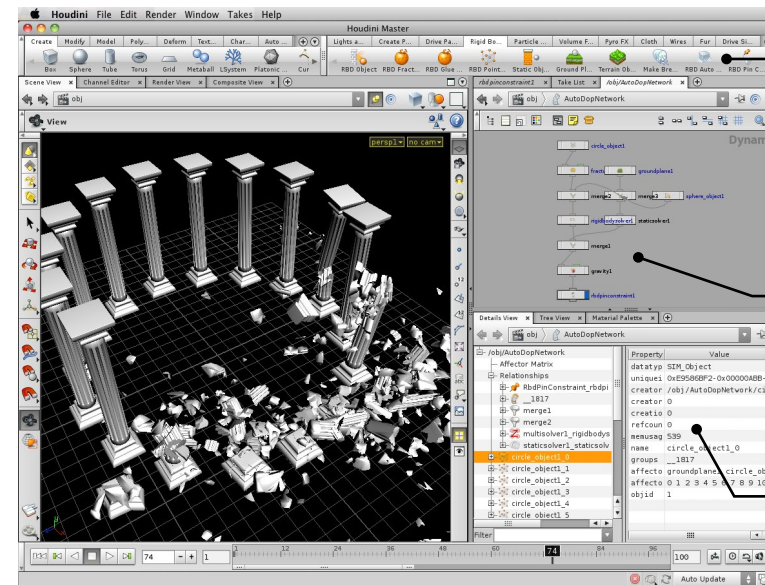
The cloth solver can also be used for simple cloth sims but is not yet ideal for fully clothed characters. Watch for that capability in future releases.



### WIRE AND FUR DYNAMICS

From tree branches to hair and fur there are many situations where Wire dynamics come into play. This solver is similar to the cloth solver but only has to worry about curves instead of complete surfaces.

When setting up fur, you have a full shelf of tools to help you set up and groom your creature including an **Add Dynamics** tool to apply the wire solver.



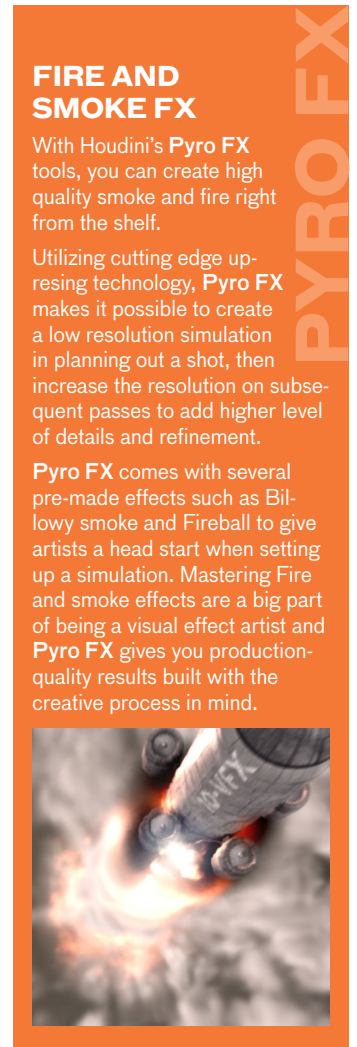
**Dynamic Tools** - The Rigid body, Fluids, Pyro FX, Cloth and Wire tools are found on different shelves on the right. These tools let you convert objects into dynamic objects and then apply forces and constraints to affect simulations.

**Dynamic Network** - This is where the dynamic operators [DOPs] are wired together. While other network types flow from the top down, nodes interact both up and down a DOP network. This way the parts of a simulation take into consideration all the other parts.

**Details View** - This view lets you analyze the objects, forces and constraints involved in a dynamic simulation and keep track of how they are interconnected.

## INTEGRATED DYNAMIC SOLVERS

In the DOPs context, you can integrate different solvers into the same network. For instance, fluids and rigid bodies can interact to create a richer simulation which takes into account all the related objects. This ability to integrate solvers is one of the key benefits of doing your sims in Houdini.



## FIRE AND SMOKE FX

With Houdini's **Pyro FX** tools, you can create high quality smoke and fire right from the shelf.

Utilizing cutting edge up-resing technology, **Pyro FX** makes it possible to create a low resolution simulation in planning out a shot, then increase the resolution on subsequent passes to add higher level of details and refinement.

**Pyro FX** comes with several pre-made effects such as Billowy smoke and Fireball to give artists a head start when setting up a simulation. Mastering Fire and smoke effects are a big part of being a visual effect artist and **Pyro FX** gives you production-quality results built with the creative process in mind.

# Keyboard Shortcuts

As you begin working with Houdini, it is useful to become familiar with some typical keyboard shortcuts which are built right into Houdini.

To create your own custom shortcuts use the **Edit > Hotkeys** menu item or press **Ctrl+Alt+Shift** and then **LMB-click** a UI item to call it up in the hotkey editor.

## THE TAB MENU

To access tools in both the Scene view and the Network editor, use the Tab key to bring up a menu of operations. If you know which tool you are looking for then you can begin spelling out the name and a list of tools using those letters will appear.



# TIP

### TOOLS

Select
Move
Rotate
Scale
Handle
View
Tool Menu
Repeat Last Tool

### SELECTION MODES

Objects	1
Points	2
Edges	3
Primitives (Faces)	4
Vertices	5
Particles	6
Dynamics	7
Toggle Object/Geometry	F8

### SNAPPING

Grid	x
Primitive (Curve)	c
Point	v
Multi-Snapping	Ctrl[Cmd] + j

### VIEW TOOL

Tumble	Space + LMB
Pan	Space + MMB
Dolly	Space + RMB
Home Grid	Space + h
Home All	Space + a
Home Selected	Space + g

### PANES

s	Scene View	Alt[Opt] + 1
t	Network View	Alt[Opt] + 2
r	Parameters	Alt[Opt] + 3
e	Tree View	Alt[Opt] + 4
Enter	Textport	Alt[Opt] + 5
Esc	Channel Editor	Alt[Opt] + 6
Tab	Material Palette	Alt[Opt] + 7
q	Details View	Alt[Opt] + 8
	Context View	Alt[Opt] + 9

### PANE TABS

6	New Pane tab	Ctrl[Cmd] + t
7	Tear off Pane tab	Alt[Opt] + Shift + c
	Next Pane tab	Ctrl[Cmd] + Pg Down
	Previous Pane tab	Ctrl[Cmd] + Pg Up

### SCENE VIEW

Expand View	Space + b
Select View	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

### SCENE VIEW LAYOUT

Single View	Ctrl[Cmd] + 1
Four Views	Ctrl[Cmd] + 2
Two Views Stacked	Ctrl[Cmd] + 3
Two Views Side by Side	Ctrl[Cmd] + 4
Three Views Split Bottom	Ctrl[Cmd] + 5
Three Views Split Left	Ctrl[Cmd] + 6
Four Views Split Bottom	Ctrl[Cmd] + 7
Four Views Split Left	Ctrl[Cmd] + 8

### ANIMATION

Set Keyframe	k
Toggle AutoKey	Alt[Opt] + k
Key Handle	Ctrl[Cmd] + k
Key Translate	Shift + t
Key Rotate	Shift + r
Key Scale	Shift + e

### TIMELINE

Play Forward	↑
Play Back	↓
Next Frame	→
Previous Frame	←
First Frame	Ctrl[Cmd] + ↑
Next Scoped Key	Ctrl[Cmd] + →
Previous Scoped Key	Ctrl[Cmd] + ←

Scrub Timeline	LMB
Select Keys	Shift + LMB
Move/Scale	Shift + MMB

### HELP

Tools Help on Mouse Over	F1
--------------------------	----

\*\* Control [Ctrl] and Alt are used for Windows and LINUX systems while Command [Cmd] and Option [Opt] are used for the Mac