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 and find more tutorials. Go to Learning > Learning Roadmap for a comprehensive list of available materials.
Houdini is being used by many of the top VFX studios to create the CG for feature films. Here is a selected list of movies which include work created in Houdini:

**Filmography**

- G.I. Joe: The Rise of Cobra
- Superman Returns
- Spider-Man trilogy
- The Curious Case of Benjamin Button
- Cloudy with a Chance of Meatballs
- Avatar
- 2012
- The Lord of the Rings trilogy
- Matrix trilogy
- The Pirates of the Caribbean: At World’s End
- Superman Returns
- The Wild
- X-Men: The Last Stand
- Spider-Man trilogy
- Harry Potter series

**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 so that 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 render watermark and raises the resolution to 1920x1080 for animations and unlimited for stills.

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

**Milestones**

- 1987 - 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.
- 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 Apprentice Program which provides free 3D animation software to artists and students.
- Houdini Apprentice HD: The Starving Artist Apprentice HD: The Starving Artist is a full graphical version of Houdini FX which can be deployed on the farm for processing simulations, generating output files for render or managing assets.
- To learn how the different Houdini products work in production, check out the pipeline diagram on page 6.
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 painting, 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. You can even create nodes that contain other networks inside them then share these custom networks with colleagues. Instead of creating external scripts and pipeline tools to manage your work, the networks you give your 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, using Houdini Digital Assets can add amazing flexibility to your workflow. 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 direct ability can be retained deep into production and can be used to make last minute creative decisions that would 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 version-less approach to managing assets simplifies inter-studio communication and makes sure 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.

In this way, Houdini lets you easily respond to direction 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.

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 normally take lots of code in other 3D animation applications. Houdini is very much an artists tool and 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 eases the creative process.
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.

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Houdini Products
- Houdini FX
- Houdini or Houdini FXStretch
- Houdini Batch
- Houdini Interop.

VFX Pipeline
- Model
- Big Components
- Prope
- Layout
- Animate
- Light
- Composit

Animation Pipeline
- Model
- Big Components
- Prope
- Layout
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- Light
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Houdini and Houdini FX.

Modeling tools are available in Houdini and Houdini FX.

As you work, Houdini’s node-based workflow lets you make the most of every modeling action. 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 traditional 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 gives 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

When you are creating 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 result-of 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. Break out motion. Houdini has other animator-friendly tools such as Heads up display (HUD) that provides 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.

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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 large animation pipeline.

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 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. Elipsoid and simple rigging 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 jiggles 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 build 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, sub-surface-scattering 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 given these inputs can completely simulate 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 can be distributed and calculations are run 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 - Sensor lights 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 intuitive 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 render engine is used.

Lighting 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 ability to choose between micropolygon, line. 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.

- 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 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 offers everything you need to script. It 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 shader builder and support for test renderers 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.

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 Hgeo which supports 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 use in a compositor. This format is another open source project sponsored by Pixar.

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

**SHELF TOOLS**

At the top of the workspace, you will find two shelves filled with options for creating and manipulating objects, geometry, cameras, lights and effects. These tools are designed to work in the scene view and can be set up to support different ways of working. You can render your geometry to the View tool.

**VIEW TOOLS**

Here are some of the hotkey combinations available while viewing. You can skip the snowflake if you are actually in the View tool:
- **Tumble**
- **Pan**
- **Dolly**

In some cases, you will want to home in to get your bearings. These are hotkeys for that as well:
- **Home Grid**
- **Home Selected**
- **Spacebar**
- **G**

You can find the View tool in the toolbar. When you use the snowflake, you temporarily activate the view tool without interrupting the use of your current tool.

**DISPLAY MENUS**

The way in which objects appear in the scene view can be set up using the following three menus:
- **Shading Menu**
- **Object Display Menu**
- **Views Menu**
Nodes and Networks

With Houdini’s node-based workflow at the heart of its procedural approach, the ability to work with these nodes 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 the 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 panels.

In the network pane, you will need to pan and zoom to manage the look of your network. Use the left and right arrow keys to move within 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 keep your network or to other 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 flip of the bottom to quickly find the node you need.

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

NAVIGATING NETWORKS

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 hotkey work with selected nodes.

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.

To 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’...
One of the first things an artist does when faced with a new application is to dive into the software. One of the first questions which arises is to “how do I select and manipulate 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 into 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.

**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.

**SELECTION MODE OPTIONS**

Each of the selection modes comes with several selection options if you want to see these all at once. You can also use the hotkeys to view the option then unpinned networks will jump to the selected node and makes the appropriate handles appear.

- **Objects**
- **Points**
- **Edges**
- **Faces**
- **Vertices**

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 handles do not work when you use 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**
- **Divide into the Geometry level**
- **Divide back up to the Object level**

**Particles and Dynamics** - These selection modes let you find Objects and parts of a subdivided geometry as bones, null objects, lights or any other active nodes. In this case, the Subdivision option should appear.

**SELECTIONS**

Making selections and transforming is a workflow you will perform on a regular basis in the Scene view and can be done while you work interactively.

**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**

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

**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 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 in the geometry.

**Selections in the Scene view**

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

- **Select**
- **Move**
- **Rotate**
- **Scale**

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.
**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 setup playback and moving through time:

- **Play Forward**
- **Play Back**
- **Next Frame**
- **Previous Frame**
- **First Frame**
- **Previous Scoped Key**
- **Next Scoped Key**
- **Current Time**
- **Frame Range**
- **Current Time**

**SCOPED CHANNELS**

When you set a keyframe or look at animation curves in the channel editor, you will be presented with what are called scoped channels which are scoped to 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 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.

Here are the main hotkeys used to set keyframes on your objects while working in the scene view:

- **Set Keyframe**
- **Toggle AutoKey**
- **Key Translate**
- **Key Translate**
- **Key Scale**
- **Key Shape**
- **Key Space**
- **Set Keyframe**

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 one keyframe per parameter at a time.

**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 animation curves using tangent handles. The curves define the motion in-between the keyframes. You can play a keyframe to see the quality of the motion.

While working with channels you can change which keys you are viewing using these hotkeys:

- **Hotkeys**
  - **Spacebar**
  - **MMB**
  - **RMB**
  - **LMB**

Motion FX can be applied to keyframed motion which is extracted and stored in a Channel CHOP. You can also 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.

The easiest way to create a channel operator is using MotionFX which can be found when you choose Motion FX > Motion FX > Accessing Motion FX in the RMB context menu in the Channel Editor.

**CHANNEL OPERATORS AND MOTION FX**

**Flippbook Previews**

As you animate your scene, you will want to view the results. The Flippbook tool found on the toolbar on the left side of the Scene view allows you to view a series of frames from the viewport then playback the results as a movie. You can also use Flippbook 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 Flippbook.

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

**Editor Options - The editor can be changed to operate on a single channel or a channel group. You can also switch the type of channel editor which is most appropriate.**

**Channel Groups - This area of the graph shows you channel groups which have been defined AND PIN your scoped channels.**

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

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

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

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

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.

**Materials**

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

- **Render Menu**
  - Go here to create render operators, start a render or set your render options.
  - Go here to create lights and cameras.
- **Lights and Cameras Shelf**
  - Go here to create lights and cameras. You can choose from point lights, spot lights, area lights, environment lights and more.
  - Mantra ROP - This node contains parameters needed to define a Mantra rendering including multiple channels for setting up render layers. You can choose 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 Renderers**

Houdini comes with a built-in Mantra renderer. This production proven solution offers a renderer which is in a class of its own. Mantra ROP style rendering is a hybrid of traditional and the newer Vray style rendering called Physically Based Rendering (PBR). The new approach offers more realistic daylight while the traditional style offers speed. You can choose to combine the two or use just one. Rendering 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.

**Lighting and Rendering Pipeline**

Houdini offers a great framework for lighting and rendering your shots whether you use Houdini's built-in render 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.
- **Inspector Tool**
  - If your RMB-click in the render view you get access to special tools such as Inspector.
  - Positioning - You can manipulate handles belonging to lights/cameras or you can view through the lights/cameras. Lock Camera/Light to View and then use Tumble, Track and only update their position.

**Render Outputs Nodes**

Houdini has a dedicated context just for output nodes called Render Operators (ROPs). In this context, you can choose to create output channels depending on what 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.

- **Wedge ROP**
  - Lode a 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 Mplay to display 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 great for quick evaluations of lighting and shading.

**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 outside 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.

**Houdini**

Houdini 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.

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

**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 instance tools and various constraints, this solver can be used to achieve a wide range of destruction shots as seen in many VFX shots. Houdini’s strength in VFX is 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. 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.

**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 debri or whitecaps.

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

**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.

**DYNAmIC TOOLS**

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

**CLOTH DYNAMICS AND PLASTIC DEFORMATIONS**

- The cloth 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.

**WIRE AND FUR DYNAMICS**

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

**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 debri or whitecaps.

**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.

**Pyro FX** comes with several pre-made effects such as Elastic smoke and Flammable to pre-arts a head start when setting up simulations. Mastering Fire and smoke effects are a big part of being a visual effect artist and Pyro FX gives you production-ready tools to help with the creative process in mind.

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 particles and simulation tools but also a procedural approach which makes your effects easy to control and thereby directable.
# 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.

## Tools

<table>
<thead>
<tr>
<th>Letter</th>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>s</td>
<td>Select</td>
</tr>
<tr>
<td>t</td>
<td>Move</td>
</tr>
<tr>
<td>r</td>
<td>Rotate</td>
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<tr>
<td>e</td>
<td>Scale</td>
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<tr>
<td>Enter</td>
<td>Handle</td>
</tr>
<tr>
<td>Esc</td>
<td>View</td>
</tr>
<tr>
<td>q</td>
<td>Tool Menu</td>
</tr>
<tr>
<td>q</td>
<td>Repeat Last Tool</td>
</tr>
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## Selection Modes

<table>
<thead>
<tr>
<th>Number</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objects</td>
</tr>
<tr>
<td>2</td>
<td>Points</td>
</tr>
<tr>
<td>3</td>
<td>Edges</td>
</tr>
<tr>
<td>4</td>
<td>Primitives (Faces)</td>
</tr>
<tr>
<td>5</td>
<td>Vertices</td>
</tr>
<tr>
<td>6</td>
<td>Particles</td>
</tr>
<tr>
<td>7</td>
<td>Dynamics</td>
</tr>
<tr>
<td>F8</td>
<td>Toggle Object/Geometry</td>
</tr>
</tbody>
</table>

## Snapping

<table>
<thead>
<tr>
<th>Letter</th>
<th>Snapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>Grid</td>
</tr>
<tr>
<td>c</td>
<td>Primitive (Curve)</td>
</tr>
<tr>
<td>v</td>
<td>Point</td>
</tr>
<tr>
<td>Ctrl+Cmd + j</td>
<td>Multi-Snapping</td>
</tr>
</tbody>
</table>

## View Tool

<table>
<thead>
<tr>
<th>Tool</th>
<th>Key Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumble</td>
<td>Space + LMB</td>
</tr>
<tr>
<td>Pan</td>
<td>Space + MMB</td>
</tr>
<tr>
<td>Dolly</td>
<td>Space + RMB</td>
</tr>
<tr>
<td>Home Grid</td>
<td>Space + h</td>
</tr>
<tr>
<td>Home All</td>
<td>Space + a</td>
</tr>
<tr>
<td>Home Selected</td>
<td>Space + g</td>
</tr>
</tbody>
</table>

## Scene View Layout

<table>
<thead>
<tr>
<th>Layout</th>
<th>Key Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single View</td>
<td>Ctrl[Cmd] + 1</td>
</tr>
<tr>
<td>Four Views</td>
<td>Ctrl[Cmd] + 2</td>
</tr>
<tr>
<td>Two Views Stacked</td>
<td>Ctrl[Cmd] + 3</td>
</tr>
<tr>
<td>Two Views Side by Side</td>
<td>Ctrl[Cmd] + 4</td>
</tr>
<tr>
<td>Three Views Split Bottom</td>
<td>Ctrl[Cmd] + 5</td>
</tr>
<tr>
<td>Three Views Split Left</td>
<td>Ctrl[Cmd] + 6</td>
</tr>
<tr>
<td>Four Views Split Bottom</td>
<td>Ctrl[Cmd] + 7</td>
</tr>
<tr>
<td>Four Views Split Left</td>
<td>Ctrl[Cmd] + 8</td>
</tr>
</tbody>
</table>

## Animation

<table>
<thead>
<tr>
<th>Action</th>
<th>Key Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set Keyframe</td>
<td>k</td>
</tr>
<tr>
<td>Toggle AutoKey</td>
<td>Alt[Opt] + k</td>
</tr>
<tr>
<td>Key Handle</td>
<td>Ctrl[Cmd] + k</td>
</tr>
<tr>
<td>Key Translate</td>
<td>Shift + t</td>
</tr>
<tr>
<td>Key Rotate</td>
<td>Shift + r</td>
</tr>
<tr>
<td>Key Scale</td>
<td>Shift + e</td>
</tr>
</tbody>
</table>

## Timeline

<table>
<thead>
<tr>
<th>Action</th>
<th>Key Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Play Forward</td>
<td>↑</td>
</tr>
<tr>
<td>Play Back</td>
<td>↓</td>
</tr>
<tr>
<td>Next Frame</td>
<td>→</td>
</tr>
<tr>
<td>Previous Frame</td>
<td>←</td>
</tr>
<tr>
<td>First Frame</td>
<td>Ctrl[Cmd] + ↑</td>
</tr>
<tr>
<td>Next Scoped Key</td>
<td>Ctrl[Cmd] + →</td>
</tr>
<tr>
<td>Previous Scoped Key</td>
<td>Ctrl[Cmd] + ←</td>
</tr>
</tbody>
</table>

## Scene View

<table>
<thead>
<tr>
<th>Tool</th>
<th>Key Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expand View</td>
<td>Space + b</td>
</tr>
<tr>
<td>Select View</td>
<td>Space + n</td>
</tr>
<tr>
<td>Perspective View</td>
<td>Space + 1</td>
</tr>
<tr>
<td>Top View</td>
<td>Space + 2</td>
</tr>
<tr>
<td>Front View</td>
<td>Space + 3</td>
</tr>
<tr>
<td>Right View</td>
<td>Space + 4</td>
</tr>
<tr>
<td>UV View</td>
<td>Space + 5</td>
</tr>
<tr>
<td>Toggle Wireframe/Shaded</td>
<td>w</td>
</tr>
<tr>
<td>Display Options</td>
<td>d</td>
</tr>
</tbody>
</table>

## Help

<table>
<thead>
<tr>
<th>Action</th>
<th>Key Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools Help on Mouse Over</td>
<td>F1</td>
</tr>
</tbody>
</table>

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