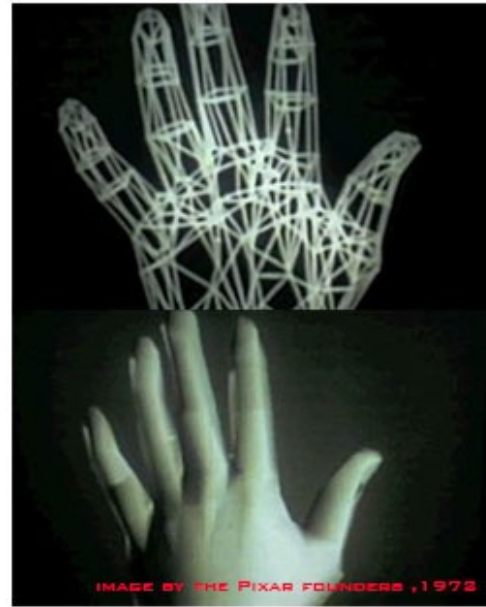


3D Computer Graphics:

Animation is an art form created and cultivated over the last century. While drawing, painting, sculpting and photography allow artists to represent shape and form at a single point in time, animation lets artists explore a world in motion. Through animation, new worlds can be imagined. This modern art form evokes emotion through the movement of a sequence of drawings, paintings, photographs or rendered images.



3D Computer Animation:

The world of 3D computer graphics has grown from experimental short films to full integration into the creative process for many types of media. From flying logos to digital actors, the field of 3D computer graphics has evolved rapidly over the last two decades. The use of 3D graphic tools is now an important part of many television, film and multimedia projects.



Feature Films:

The last few years have seen a sharp rise in the use of 3D in feature films. While many films have integrated 3D into existing live-action scenes, Pixar's Toy Story® became the first feature-length animation that used 3D exclusively for characters and sets. Sony Pictures Image works' Stuart Little® took this one step further and made a digital mouse the star of a live-action movie. Digital creatures, characters and sets continue to show up in the movies and even traditional filmmakers are starting to consider 3D a standard part of the production process.



Interactive Video Games

Over the years, video games have developed from black and white pixels to real-time virtual environments built with 3D characters and sets. Game artwork is becoming more sophisticated with complex 3D models, texture maps, lighting and even dynamics. Maya is an ideal tool for generating this kind of 3D artwork and includes tools to address the special needs required to build content for real time.



Visual Effects:

While CG actors star in movies of their own, 3D computer graphics is changing how visual effects are used for both film and television. Smaller productions can now afford to integrate 3D graphics into their work, while lar



Right and Left Brain Thinking with Maya

- The creative side of Maya offers you tools that make it easy to work in a 3D world with shape and form. These tools free you up to make creative decisions on your project.
- The technical side of Maya offers you access to the inside workings of both your scenes and Maya itself. This access makes it possible to build your own custom tools and to speed up production where repetitive tasks appear.

Left Brain Thinking

The Technical Edge

Maya has many editors that give you access to all parts of a scene. For example, the Attribute Editor can access the mathematical values assigned to all objects, shaders and animated sequences in your scene.

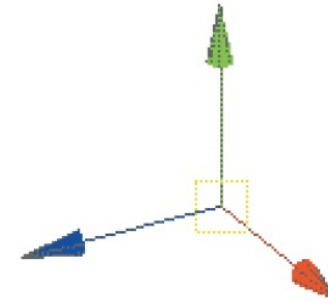


Maya lets you group objects together to build complex hierarchies. These groups help you organize your models while offering methods of animating complex objects.

Right Brain Thinking

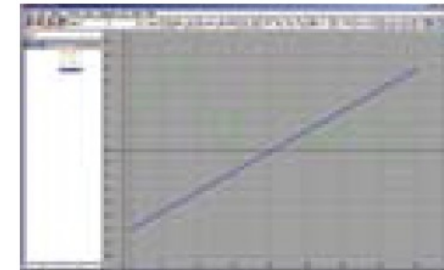
The Creative Edge

Many tools in Maya use Manipulator Handles to offer visual clues as you edit an object. By using the manipulator, you are able to make your decisions visually without relying on the actual numbers stored in Maya.



Materials and textures are presented visually using icons and swatches that help you make decisions. This is one step in the creation of rendered scenes. Material changes can also be explored using Maya IPR (Interactive Photorealistic Rendering).

Maya includes fully shaded and textured views so that what you see in your interactive scene resembles what your final rendering will look like.



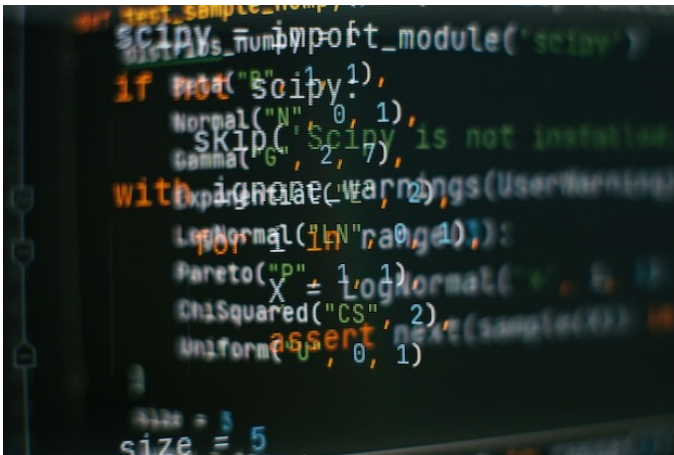
Animation information is presented in visual graphs that help you visualize motion. This makes all the numbers easier to understand. You can then easily edit this graph in the same way you would edit a curve in 3D.

Mathematics, Scripting and Programming

Mathematics is used by Maya in a number of ways: objects in Maya exist in a 3D coordinate system, colours are stored as RGB values, and animation is created as values that are mapped against time.

A Maya scene is basically a database of numbers that is interpreted by the software into geometry, colour and texture.

Maya is built on MEL (Maya Embedded Language) Python scripting , a scripting language that you can use to build custom tools and workflows.



Creative Awareness

One of the goals of creating artwork in a 3D graphics application such as Maya is to mimic the real world. This means that the more you are aware of the world around you, the easier it will be to recreate it on the computer.

While watching movies, observe camera angles, set lighting, the staging and framing of actors, and performances. An understanding of how people, places, colour, shape and form are captured on film can help you become a better animator.



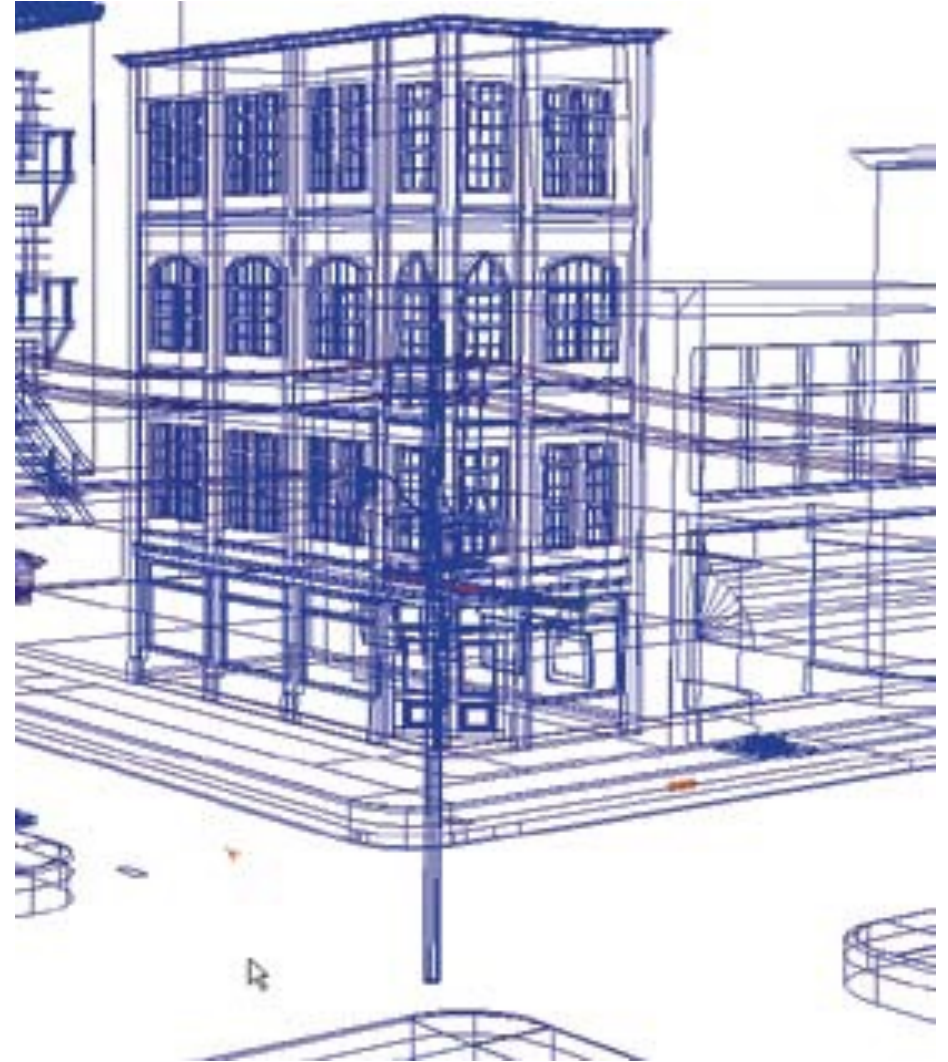
Modelling, Animating and Rendering

The animation pipeline can be summarized in seven stages: modelling; characters; animation; materials and textures; lights and cameras; effects; and rendering and compositing.

Each stage of 3D animation is a full area of study on its own. It is useful to be familiar with all the stages, even if you find yourself focusing on only one later on.

Modelling

This is the stage where you build geometry to represent objects and characters. This geometry describes the position and shape of your models and can be manipulated in the 3D workspace of Maya.



Characters:

Characters are models that use special controls such as skeleton joints and inverse kinematics for animation. These controls make it possible to create the complex mechanics required by characters.



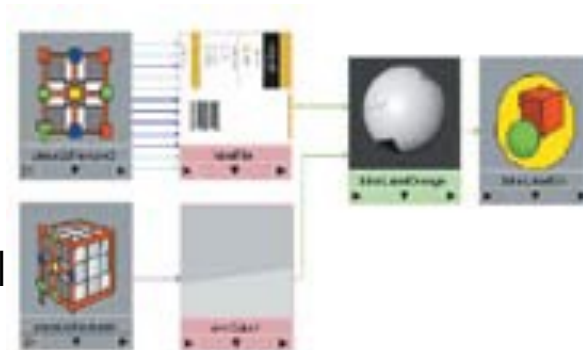
Animation:

Once a model has been setup for animation, you can begin to animate it. By changing its position or shape over time, you bring it to life. The timing can then be tweaked to create very specific motion.



Materials and Textures:

In order for geometry to be rendered, it must be given material attributes that define how it will be shaded by light. Texture can also be added to bring detail and visual richness to the surfaces.



Lights and Cameras

As you would on a movie set, you must set up lights and cameras to illuminate and frame objects. You can then animate both the lights and the camera to further mimic Hollywood effects.



Effects

There are many effects such as fire, fields of grass and glowing lights that can't be easily represented using models and textures. Tools such as particles and Maya Paint Effects can be used to add effects.



Rendering and Compositing

Once all the scene's parts are ready, you can render a single image or a sequence of images. You can also render objects separately, then bring them back together in 2D using a compositing system.



Animation pipeline:

From the perspective of a Maya user, several stages use animation as their foundation—such as modelling, characters and effects.



Modeling



Materials
and Textures



Characters



Lights
and Cameras



Effects



Animation



Rendering



Compositing

Production Pipelines:

The way in which you approach the animation pipeline will depend on the environment you create in.

Single Artist:

As a lone artist, you will be in charge of all aspects of the production process. You will, therefore, work in a more linear fashion. As technical lead for yourself, you may want to set up a consistent control strategy for your characters and scenes so that when you are animating you can think more creatively.

Small Production House:

In a smaller production house, the focus is on cutting production time and making the most of limited resources. You will be called upon to play a few roles, although some specialization will occur. Custom tools may be put into place to streamline production.

Large Production House:

In a large production house, specialization is more likely. You will focus on either modelling, texturing, lighting, animating, effects or rendering. Technical leads will take care of custom tools and character rigging. Maya will also be part of a larger production tool kit and MEL scripts and plugins will be required for data transfer to proprietary tools.

Gaming Company:

A game company can work like either a small or large production house. Here the focus is on modelling with polygons, setting up texture UVs, painting textures and animating. The exact workflow for your models and scenes will depend on the game engine and which custom tools are available for exporting

Student:

If you are at school and working on a production, you can either work alone, which may limit the complexity of your animation, or you can work with your fellow students to create a production house scenario. Here you would choose an area of expertise and specialize in that area with your classmates' support



3D Space:

Three-dimensional objects can be measured and quantified. If you have ever measured the length, width and height of an object, you have analysed its three dimensions. You can also determine an object's position by measuring it in relation to another object or to a point in space. In Maya, you can explore three-dimensional objects and recreate them on screen as rendered images complete with lights and shadows.



Two Dimensions

When you measure the width and height of an object, you are analyzing two of its dimensions. The X and Y axes can be used to find points on an object, such as the center of the wheel or the position of the headlight in this two-dimensional space.



Three Dimensions

When you measure the length, width and height of an object, you must consider a third dimension as defined by the Z-axis when defining points in space.

Origin

Points in a 3D coordinate system are measured against an origin point. This point is assigned a value of 0, 0, 0.

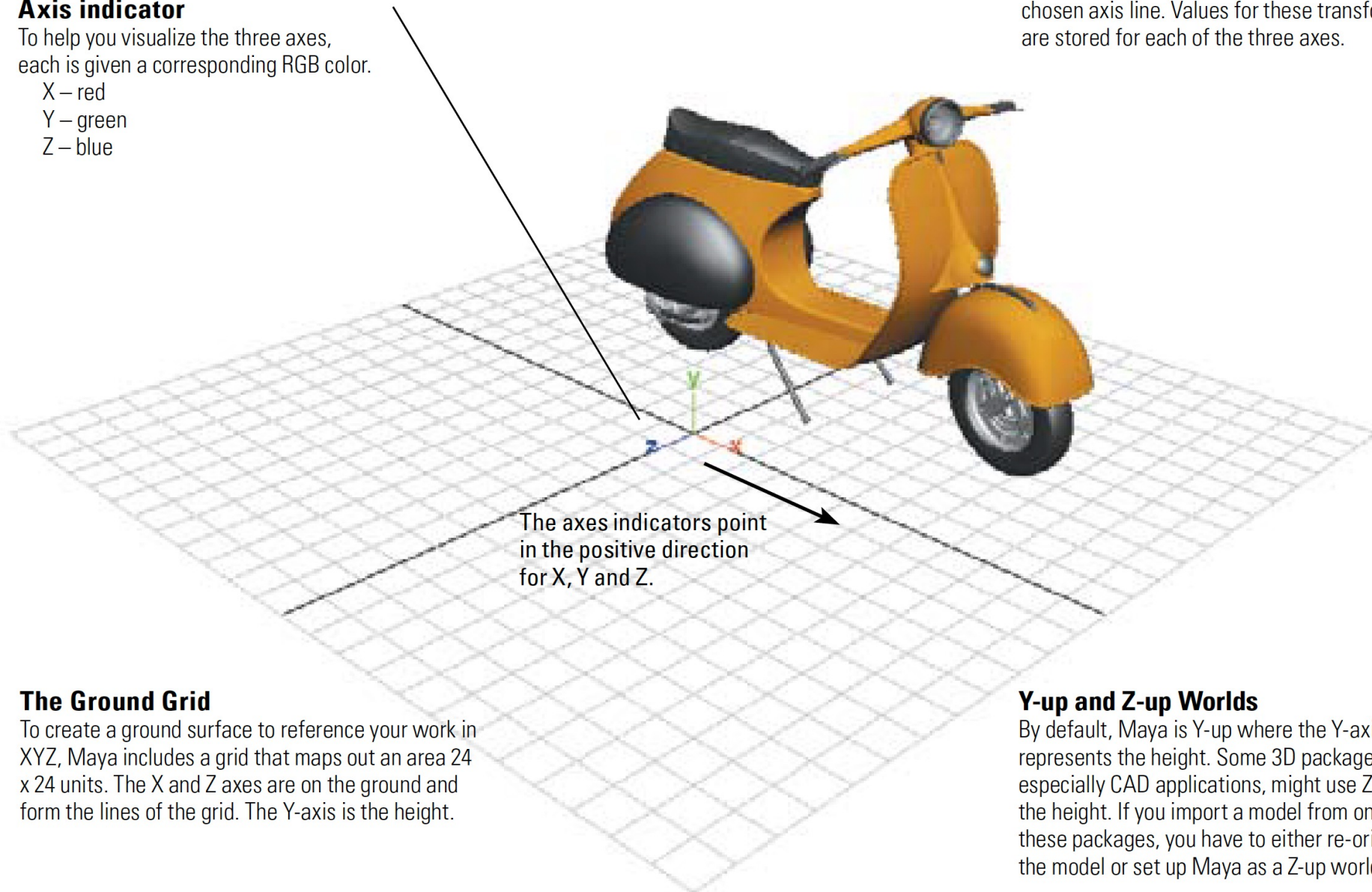
Axis indicator

To help you visualize the three axes, each is given a corresponding RGB color.

X – red
Y – green
Z – blue

Transformations

When an object is moved, rotated or scaled, the X, Y and Z axes are used for reference. An object is moved along, rotated around, or scaled along the chosen axis line. Values for these transformations are stored for each of the three axes.



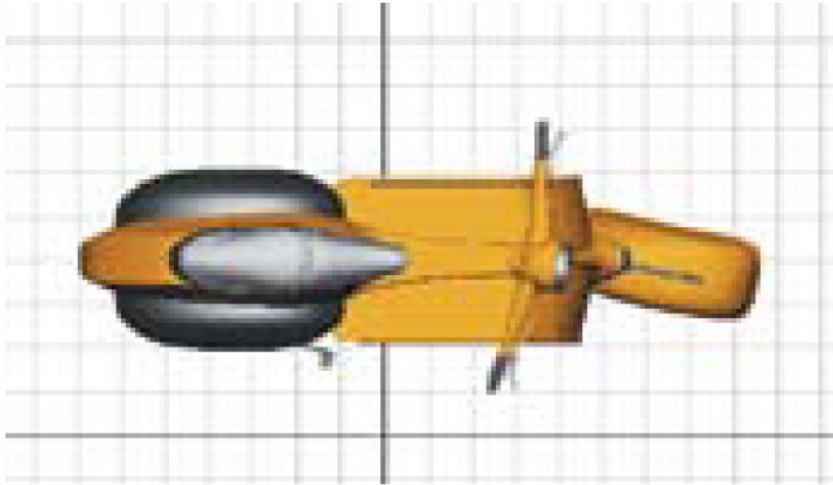
The axes indicators point in the positive direction for X, Y and Z.

The Ground Grid

To create a ground surface to reference your work in XYZ, Maya includes a grid that maps out an area 24 x 24 units. The X and Z axes are on the ground and form the lines of the grid. The Y-axis is the height.

Y-up and Z-up Worlds

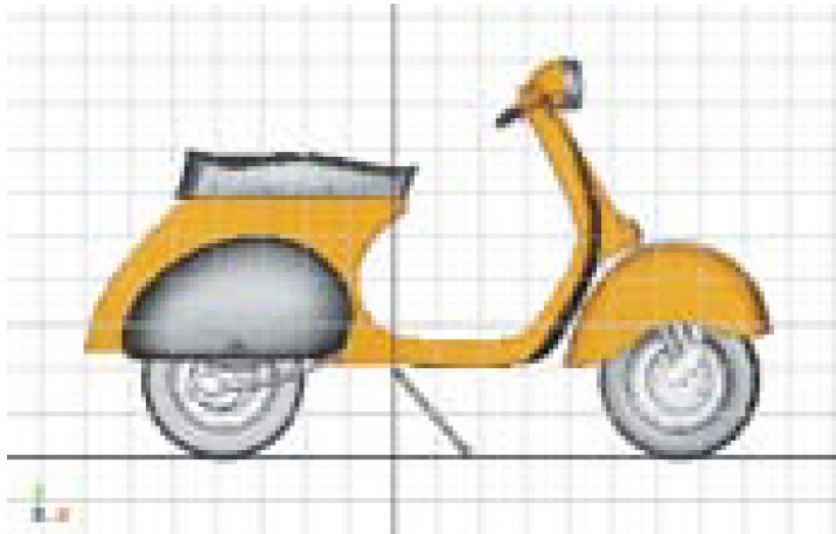
By default, Maya is Y-up where the Y-axis represents the height. Some 3D packages, especially CAD applications, might use Z as the height. If you import a model from one of these packages, you have to either re-orient the model or set up Maya as a Z-up world.



Top view



Perspective view



Front view



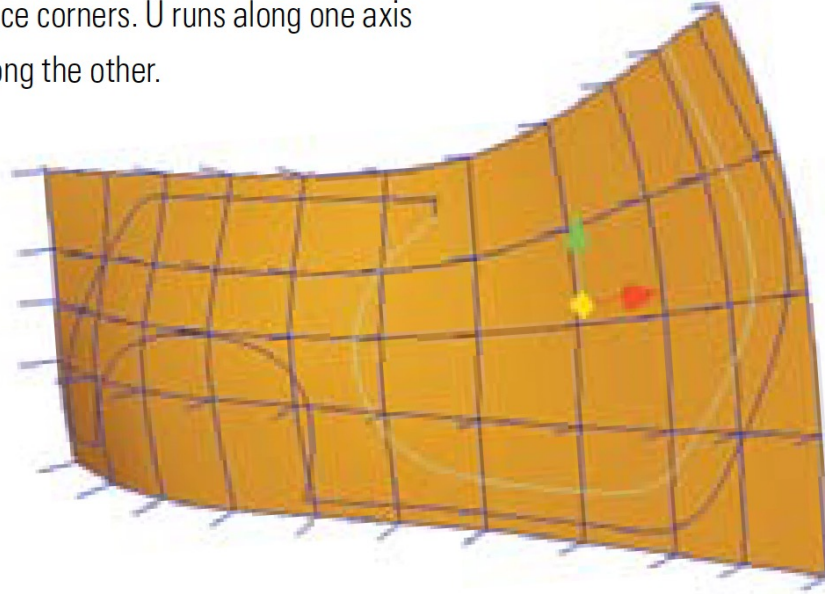
Side view

Orthographic Projections:

While a Perspective view can help you compose a shot, it is not always the ideal method for modelling and animating objects. Therefore, an Orthographic view lets you analyze your scene using parallel projections of only two axes at a time. Using these views, you can more accurately determine how an object is positioned.

UV Coordinates

The origin of the UV system lies at one of the surface corners. U runs along one axis and V along the other.



Curve-on-Surface

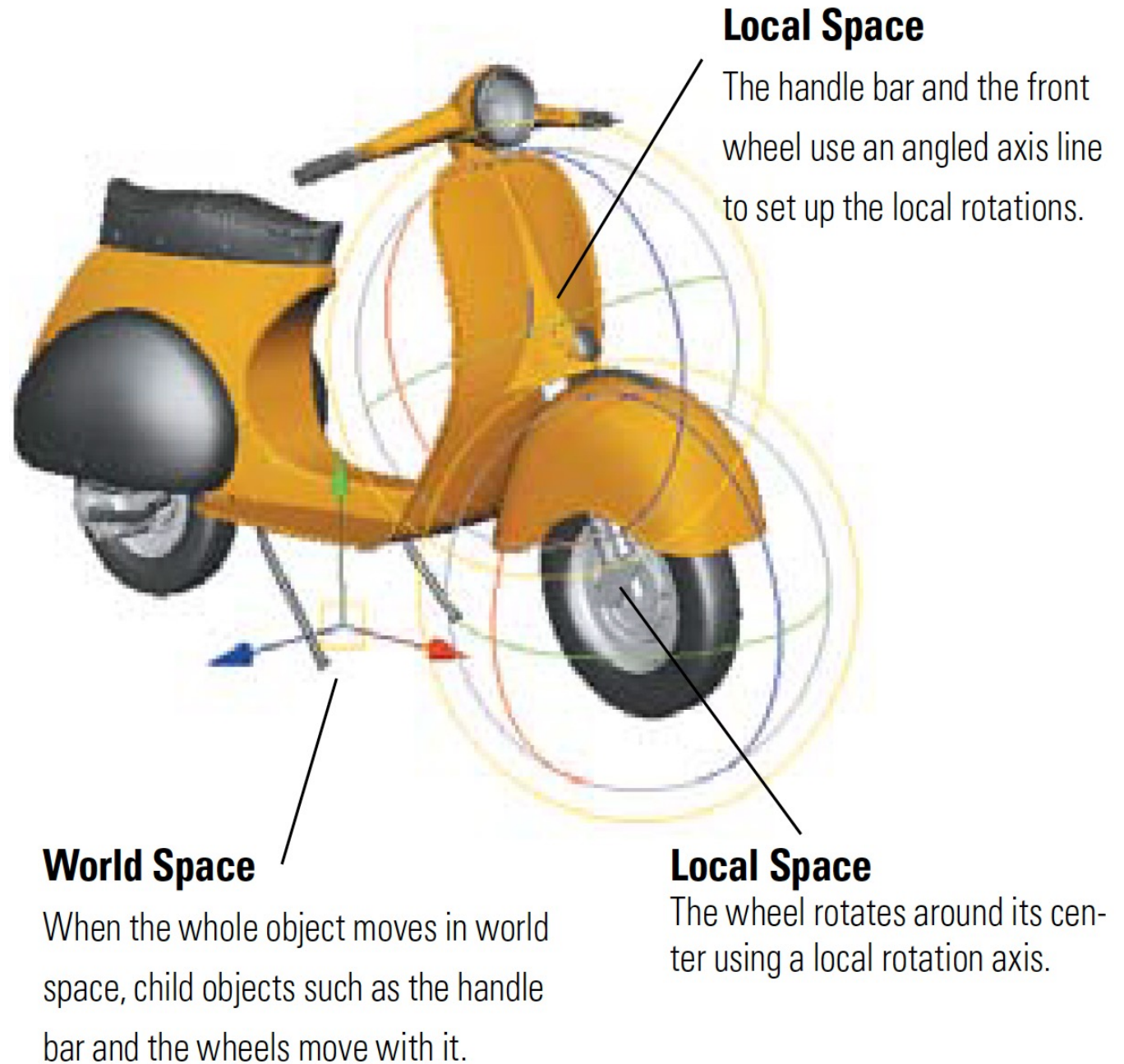
Curves can be drawn in UV space. Later edits will be in 2D along U and V axes.

UV Coordinate Space:

While surfaces are positioned in 3D space using X, Y, Z coordinates, they also have their own coordinate system that is specific to the topology of the surface. Instead of using X, Y, Z axes, this system uses U, V and N, where U and V represent the two axes that lie on the surface and N is the “surface normal” axis that points out from the front of the surface. The placement of textures can also take place in UV space.

World Space and Local Space:

When you build objects in 3D, it is possible to parent one object to another. This creates a hierarchy where the parent object determines the position of the group in world space. The child objects inherit this positioning and combine this with their own local space position. This parent-child relationship is used during the animation of an object where keyframes can be set on both the child and the parent.



Time:

World of 3D animation, time is the fourth dimension. An object will appear animated if it either moves, rotates or changes shape from one point in time to another. Therefore, learning how time works is crucial to the animation process.

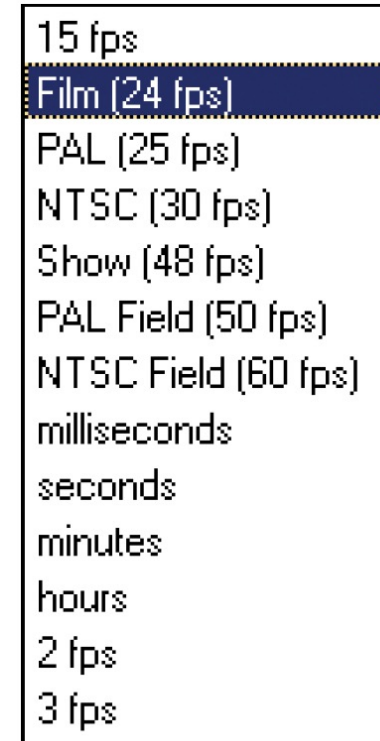
Both live-action and animation use either film or video to capture motion. Both media formats use a series of still images that appear animated when played back as a sequence.

Film and video images are often referred to as frames and most animation is measured using frame as the main unit of time. The relationship between these frames and real time differs depending on whether you are working with video, film or other digital media.



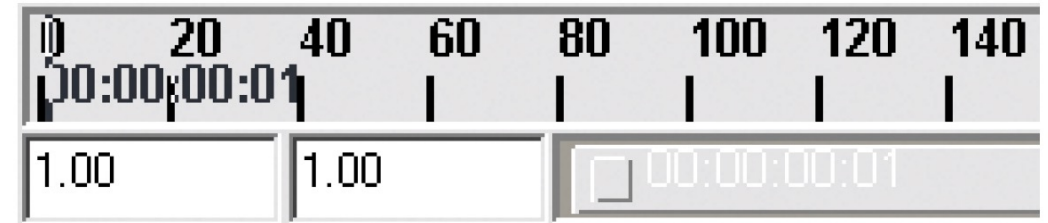
Frames per Second:

Frames can be played back at different speeds that are measured in frames per second (fps). This is known as the frame rate and it is used to set the timing of an animation. The frame rate is required to output animation to film or video and to synchronize that animation with sound and live-action footage.



Time Code:

Time code is a frame numbering system that assigns a number to each frame of video that indicates hours, minutes, seconds and frames. This gives you an accurate representation of time for synchronization. You can set up time code display in Maya from the Preferences window.



Fields:

The concept of Fields is important if you output your animation to video. To make video play back smoothly, Fields are used in place of frames. Each Field uses alternating rows of pixels—**called scanlines**—that are interlaced during playback. Fields are timed at 60 fps for NTSC “**National Television Standards Committee**” and 50 fps for PAL “**Phase Alternate Line**”, with each Field containing only half the number of scanlines as a typical frame.

Frame 1



Field 1 Odd



Field 1 Even

Frame 2



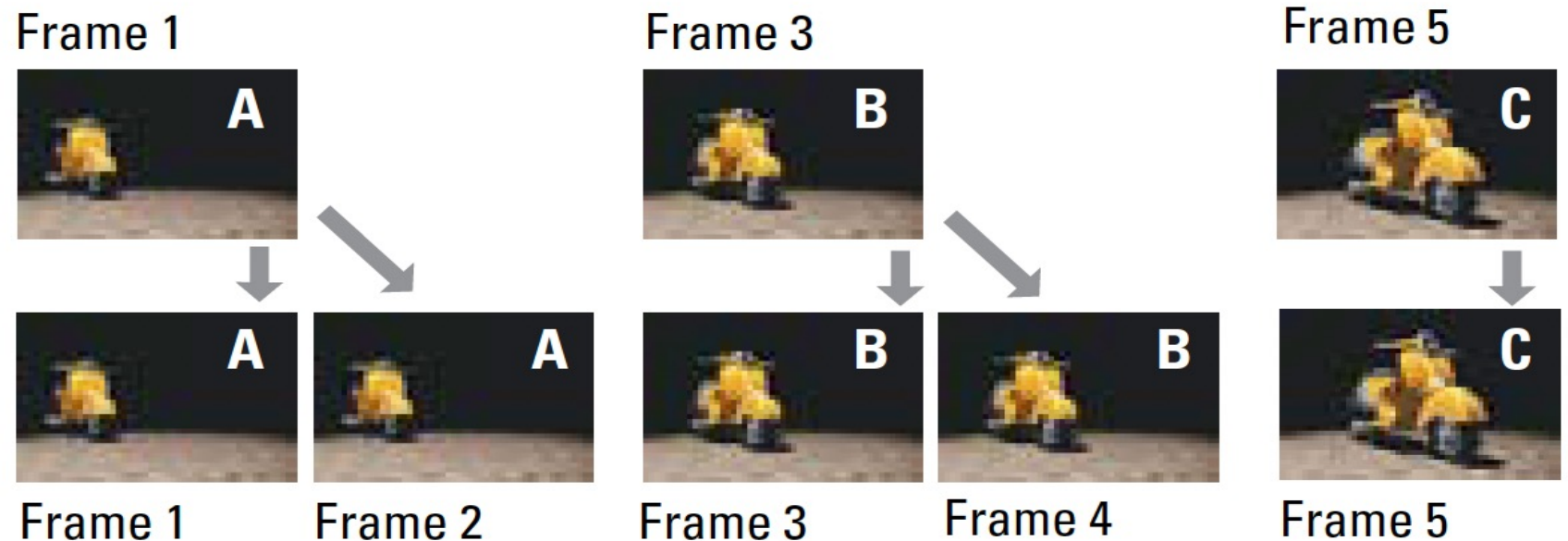
Field 2 Odd



Field 2 Even

Double Time:

At a frame rate of 24 fps, a 6 minute animation would require 8640 frames (24 fps x 360 sec). Animators working with either cel animation or stop-motion sometimes use double time, where only every second frame is created, then repeated twice. Double animations don't play back as smoothly as the full frame rate, but they save you in rendering time. Students, especially, might consider this option when confronted with a tight deadline. You can set up double time by setting By Frame to 2 in Maya Render Settings window, under the Common Settings tab.



How Objects Are Animated Using Keyframes:

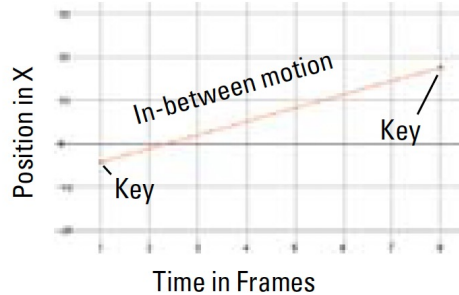
Keyframe animation is created by capturing values for attributes such as translation or rotation at key points in time. An animation curve is then drawn between the keys that defines or interpolates where the object attribute would be at all the in-between frames.

Setting Keys

When you know that your object or character needs to be at a certain place at a certain time, you set a key. With characters, you can create poses out of a number of keys set for different parts of the character.

Mapping Against Time

Two keyframes are mapped against time, then an animation curve interpolates the motion between the keys. The shape of the curve determines the quality of the motion.

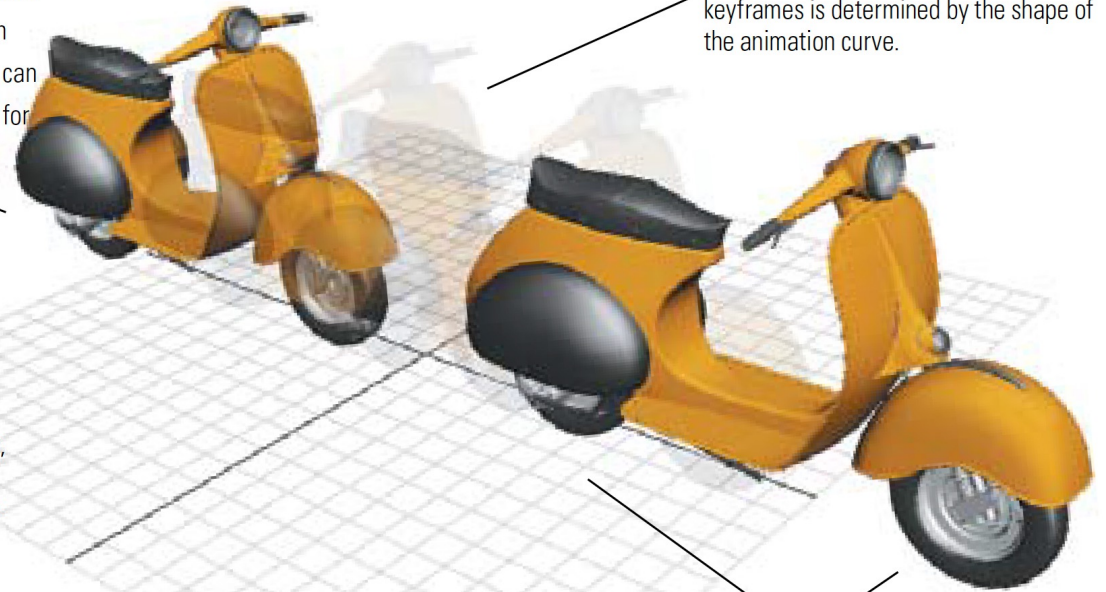


In-between

The position of objects in-between the two keyframes is determined by the shape of the animation curve.

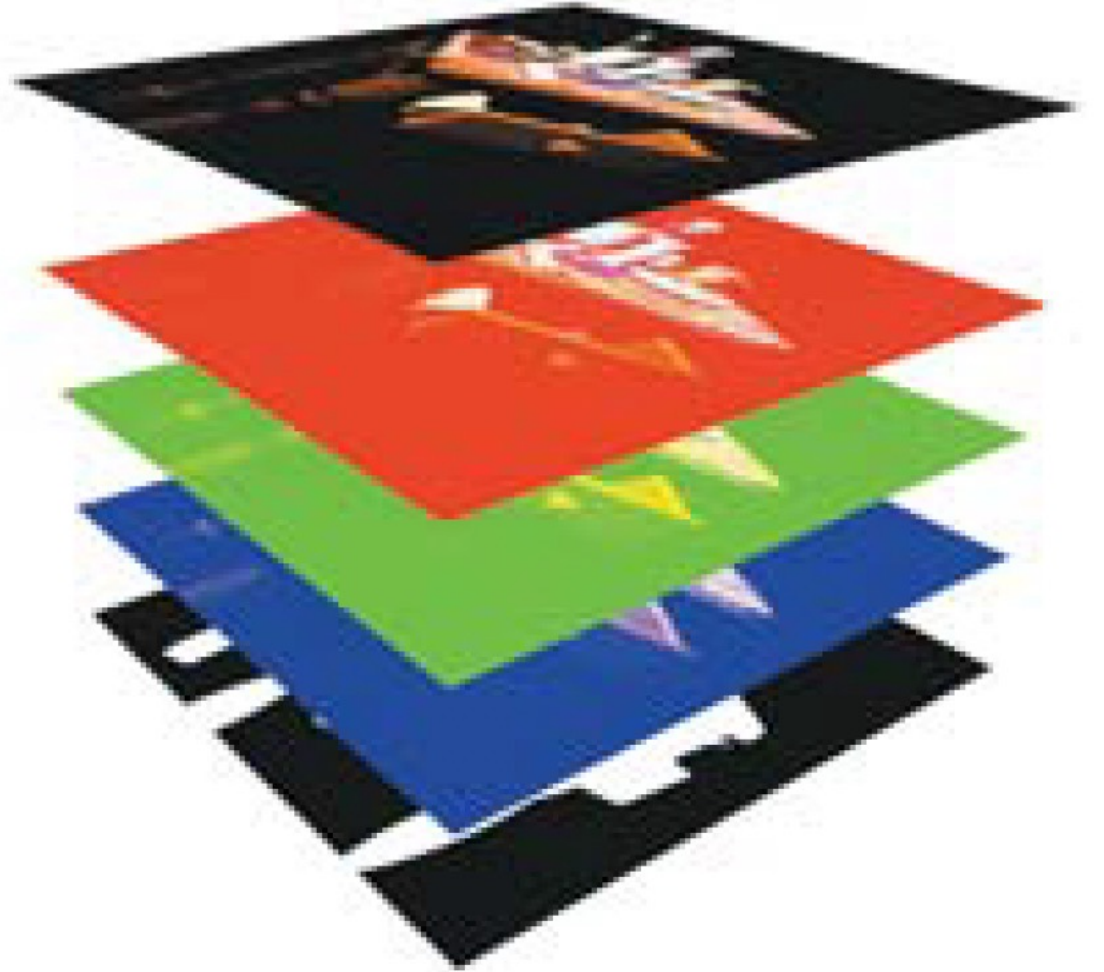
Pivot Points

You animate objects in Maya based on a single point called the pivot point. The pivot for the whole scooter would lie on the ground, while the pivot for a wheel would be at its center. The position of the pivot sets the center of the axes for rotating or scaling objects in your scene.



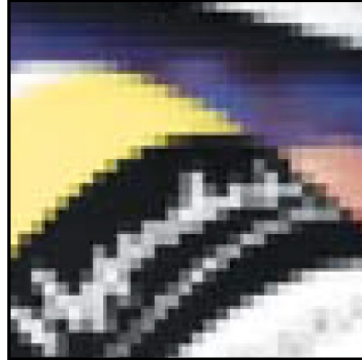
Bitmap Space:

Is a representation of an image, consisting of rows and columns of pixels, that is stored colour information. Each pixel (picture element) contains a colour value for a number of channels – red, green and blue. When you view these channels together at a high enough resolution, all of the different colours form a complete image. These images can then be output to video, film or printed on paper.



Pixels

Up close, you can clearly see the grid of pixels that make up the bitmap image.



Bitmap Channels

Each pixel is made up of at least three color values – red, green and blue. These channels combine to create the visible color.



Bitmap Sources

Bitmap images are common in computer graphics and can be created and manipulated in paint, compositing and 3D rendering packages.

Full Resolution

As pixels are presented at a higher resolution, the grid is no longer visible and you get a clearer view of the final image.

When Maya renders a scene, the geometry, lights and materials are calculated from the camera's point of view and a bitmap image or a series of images results. Further manipulation of the image in two dimensions is then possible using compositing or paint packages. Bitmap images are also used as texture maps to help add colour and detail to the surfaces in s

Image and Display Resolution:

Maya uses the term Image resolution to refer to the total pixel size of the bitmap image. Display resolution refers to how many pixels you will find in one inch on the screen. This resolution is measured in pixels per inch (ppi) or dots per inch (dpi). Monitors have a display resolution of about 72 dpi, although your graphics card may offer several settings which will alter this value.



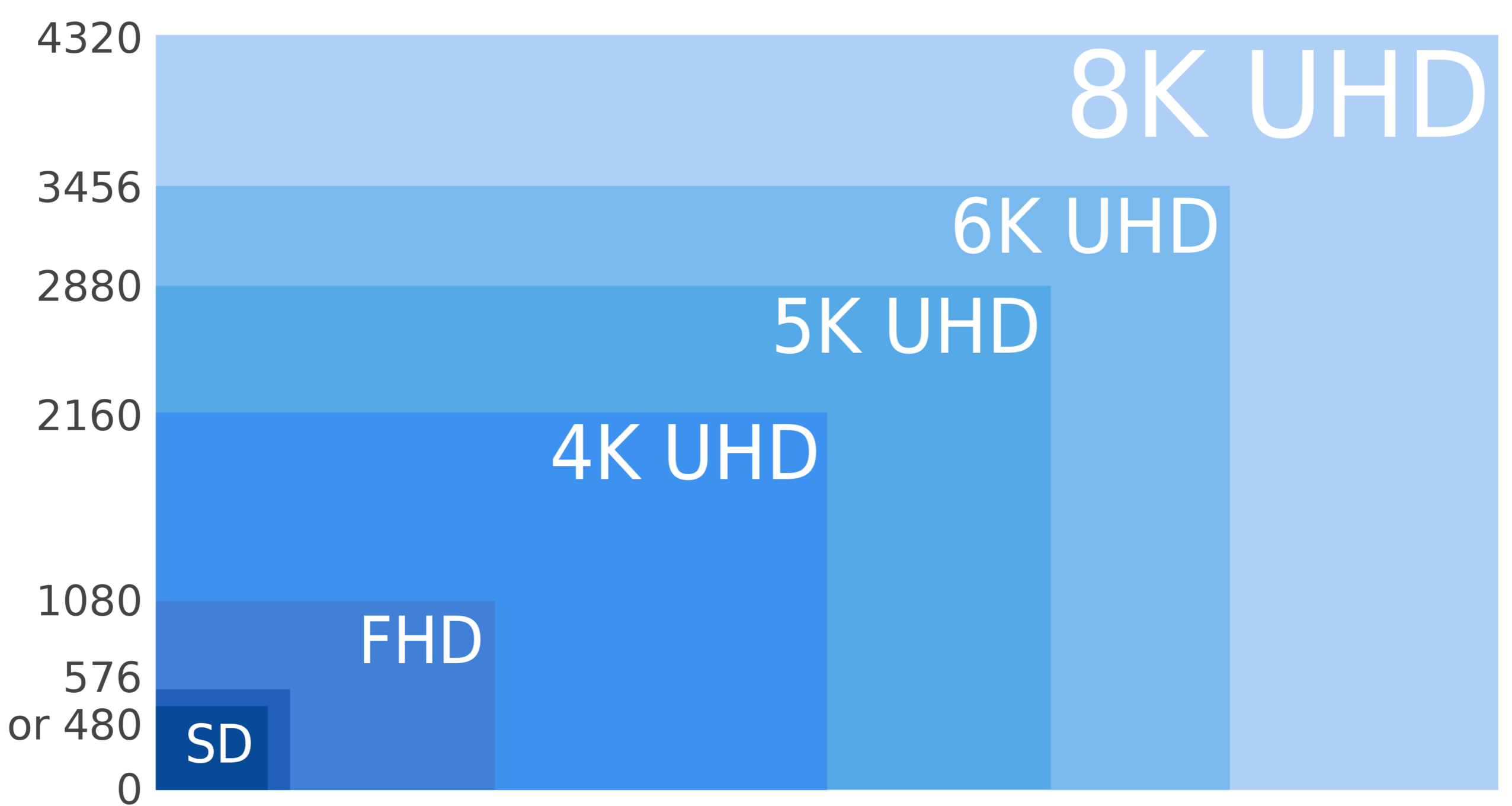
2" x 2" @ 72 dpi (144 x 144 pixels)



2" x 2" @ 150 dpi (300 x 300 pixels)



2" x 2" @ 300 dpi (600 x 600 pixels)



Aliasing and Anti-aliasing:

The bitmap image grid can create a staircase-like or jagged effect within an image where lines run diagonally against the pixel grid. To create realistic bitmap images, you must soften these jagged edges using an effect called anti-aliasing.

No Anti-aliasing

Without anti-aliasing, a bitmap image will display jagged edges where one object meets another and on the interior of a surface where a texture map can appear jagged without proper anti-aliasing settings.



With Anti-aliasing

An anti-aliased image removes the staircase-like effect by creating in-between pixels that soften the edge. This gives results that more closely resemble a real photograph that has been scanned into the computer as a bitmap.



Image Formats:

Over the years, many different image formats have been created. You can choose one of these in Maya Render Settings window. The Maya Software default format is called IFF and it handles RGB, mask, and depth channels. Maya also has several movie formats that contain sequences of bitmap frames.



Non-square Pixels:

While most bitmap images use square pixels, digital video uses pixels that are slightly taller than they are wide. Therefore, an image that uses non-square pixels will appear squashed on a computer monitor that uses square pixels.



Computer Monitor Display



Video Monitor Display

Other Channels:

In a typical bitmap, the first three channels contain colour information. You can also create other channels that offer useful information about the image. Maya is able to render images with mask and depth channels for use in compositing packages. These channels can be used when you want to layer several images together seamlessly, including live-action plates created outside Maya.



Mask Channel

A mask (or alpha) channel, defines where an image needs to be solid or transparent. This channel can be used to layer images for compositing or to texture map attributes such as transparency or bump. White is opaque and black is empty.



Depth Channel

A depth channel can provide actual 3D information about an image. Depth channels are very useful in a compositing package where you can combine layers or add effects such as fog or depth of field. White is close to camera and black is far.