

THE ONLINE TUTOR FOR QUICKTIME® VR



THE
LEARNING
ALLIANCE

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The Online Tutor for QuickTime® VR

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WELCOME!

...to the QuickTime VR Online Tutor, a self-paced course in creating QTVR panoramas, objects, and scenes. QTVR development benefits greatly from:

- understanding the photographic and geometric principles which underlie immersive imaging
- familiarity with the nuances of QTVR development processes
- paying close attention to details - like other multimedia development processes

This course will help you develop and acquire these skills for creating QTVR media.

Topics Covered



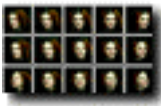
QTVR Overview

This section provides an overview of QTVR, how it works, what it does, and how you create with it.



QTVR Panoramas

The details of the underbelly of QTVR panoramic technology, with great devotion to lenses, cameras, and production tips.



QTVR Objects

The fantastic fribulations of the arcania surrounding the creation of QTVR objects, along with more than you bargained for with some basic QuickTime information.



QTVR Scenes

The splendid spelunking you can do with QTVR scenes, including how not to burn your fingers on hot spots and the various development processes you can choose from to create these stand-alone wonders.

Finished the course? Send any comments to info@letmedoit.com.

Thanks!

QTVR Overview

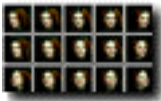


This section presents an introduction to the terms, concepts, and capabilities of QuickTime VR. QTVR encompasses three basically distinct technologies. In addition, successful QTVR development requires a certain discipline and understanding of the overall development process.



Panoramas Overview

Basic terms and capabilities of QTVR panoramas.



Objects Overview

Basic terms and capabilities of QTVR objects.



Scenes Overview

Basic terms and capabilities of QTVR scenes.



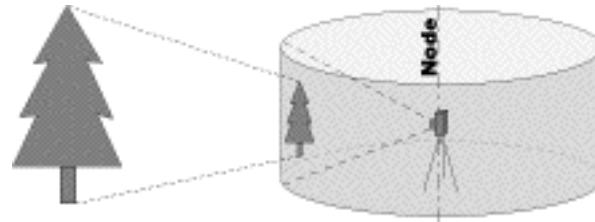
QTVR Development Process Overview

General steps of the development process for creating and using QTVR panoramas, objects, and scenes.

QTVR Overview – Panoramas

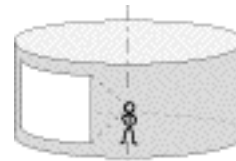


QTVR Panoramas are in essence the view from a single point in space out to a surrounding environment.

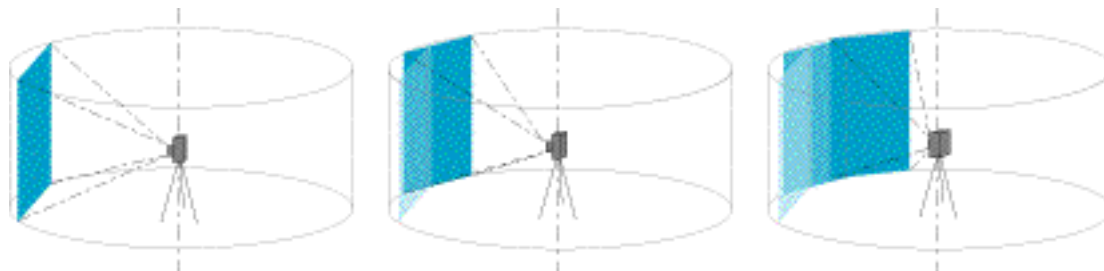


Panorama view from a single point in space

From the central observation point, called a **node**, a viewer can look in any direction and may zoom into or out from a particular view by changing the **zoom angle** of their view.



Panoramas can be created in a number of ways. The most common method is to capture a series of source images around a single point of rotation, then digitize them into source Pict files.



Individual Picts captured around a point of rotation

These source Picts are then stitched together using the QTVR tools to create a single panorama Pict image that represents a cylindrical view from the point of rotation. Alternatively, many panoramic cameras create a single panoramic image directly on film, and these may also be converted into a QTVR panorama.



A panoramic Pict

The source images for panoramas can also be created via a 3D rendering or CAD application. Most rendering programs can export a 360 degree panoramic Pict from any point in the scene. Even if a 3D program cannot do this, all rendering applications can generate a series of individual Pict files around a given point. These can be exported and then stitched together with the QTVR tools to create the panoramic Pict.

Finally, QTVR panoramas support the creation of **hot spot** areas, which function as an invisible yet detectable mask on the final panorama. Developers can use these hot spots to link panoramas to other QTVR panoramas, QTVR objects, QTVR scenes, or other media such as graphics, text, videos, and sounds via an authoring environment. Alternatively, the same hot spots can be used to reference World Wide Web sites when the QTVR panorama is included on a web page.



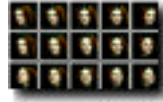
Normal panorama cursor



Cursor over a hot spot area

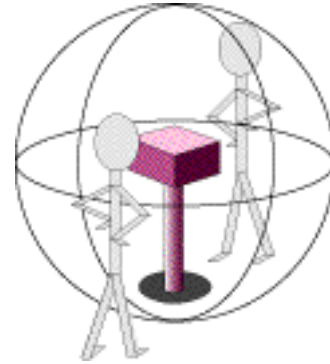
The view of the panorama which is displayed when it is initially opened is called its default view.

QTVR Overview – Objects



Where panoramas are represented by a 360 degree view from a single point in space, QTVR objects are essentially the reverse: the view from multiple points in space onto a single point, or object.

Where QTVR panoramas are composed from a single cylindrical Pict image, objects are composed from a number of individual views that have been captured or rendered. The individual views are not stitched together, but instead are placed in an ordered sequence that enables a user to shift rapidly from view to view.



Multiple views onto an object



Individual source images for a QTVR object movie of a woman's head

Depending on the number of views that have been captured and assembled, the object movie can be manipulated to provide a full or partial range of vertical and horizontal motion. In addition, animation frames can be associated with any particular horizontal and vertical view. When the object movie is created, these animation frames can be specified to play back only once, loop indefinitely, or play as a palindrome (play the first frame to last frame, then play in reverse from last frame to first frame).

Manipulating an object in space, however, is just one metaphor for how object movies are used. A different approach to QTVR objects is represented in the **absolute referenced** type of object movie.

While typical object movies rotate through the available horizontal and vertical views based on clicking and dragging a mouse, absolute referenced object movies go directly to specific frames

based on the position of the mouse within the object movie's frame window. Thus, if a user clicks in the center of the window, one view is shown, while if they click near one or another edge of the movie, a completely different frame can be shown. This type of object movie is ideal for representing a static object with various effects tied to the position of the mouse.

Like panoramas, objects also support hot spots for linking to other objects or media, and can support zooming into or out from a given view.



Normal object cursor



Cursor over a hot spot area

One additional capability of object movies, though, is their ability to directly support QuickTime audio and sprite tracks which are associated with specific views. Thus, an object movie that is panned can play a different audio track at each view in the pan, while an absolute referenced object movie can play a different audio track based upon the relative position of a mouse click within the viewing frame.

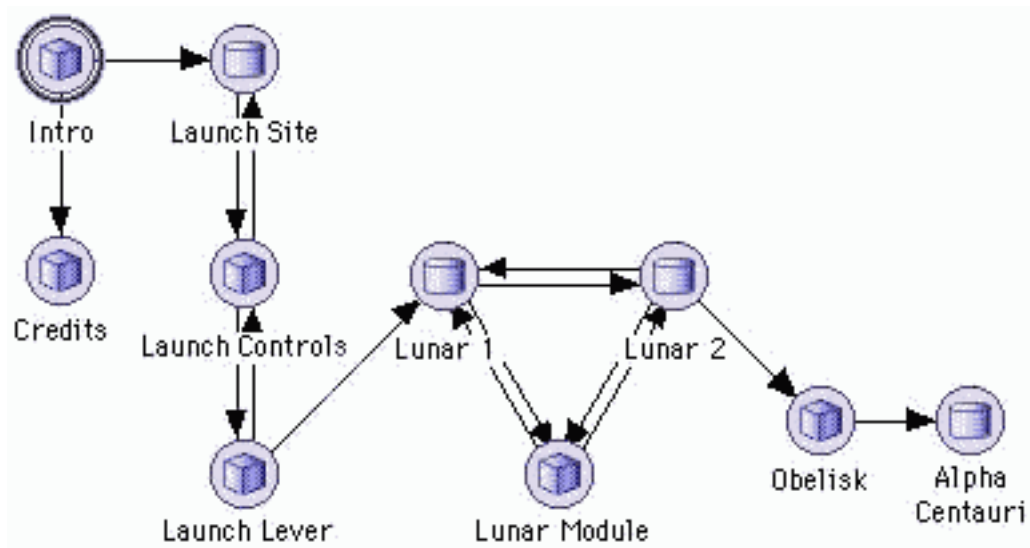
Finally, the default view of the object that is displayed when an object movie is opened is called its **poster view**.

QTVR Overview – Scenes



QTVR scenes are a collection of one or more QTVR panoramas and/or object movies linked together via a set of hot spots. In QTVR scenes, users can navigate from panorama to panorama, panorama to object, object to panorama, or object to object as they move about in the scene. The navigation between QTVR panoramas and/or objects is via the use of hot spots which are associated to a target QTVR panorama or object. The orientation and position of the link's target is defined as part of the scene building process.

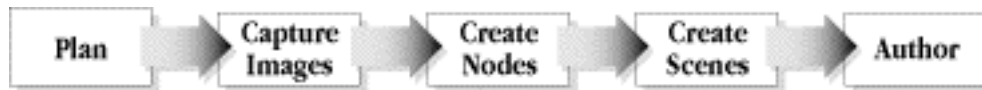
Each panorama and object in the scene is referred to as a node. Each scene has one entry node which provides the default view when the scene is opened.



Once created, QTVR scenes are saved as a self-contained file. They can play back as stand alone files on either a Macintosh or Windows machine using the MoviePlayer application (provided, of course, that the platform has the QuickTime extension installed), or directly on-line in a World Wide Web page if using the correct QuickTime plug-in with an internet browser.

If, however, the scene includes panoramas or objects which contain links to other types of media, such as graphics, text, videos, or sounds, then the scene must be incorporated into a multimedia authoring environment, such as Macromedia Director, to manipulate these other media components.

QTVR Overview – Development Process



The stages of QTVR development

Successful and efficient development of QTVR panoramas, objects, or scenes requires a certain discipline and understanding of the overall development process. At a high level, this process can be divided into five stages, with each stage depending on the efforts of previous stages. Invariably, shortcuts taken during one stage may result in costly rework processing during later stages.



The user experience is determined, story boards are produced, panoramas and object movie specifications are created, and a production timeline and budget are prepared. The details of this stage are covered in the respective QTVR Panoramas, QTVR Objects, and QTVR Scenes sections on this online course.



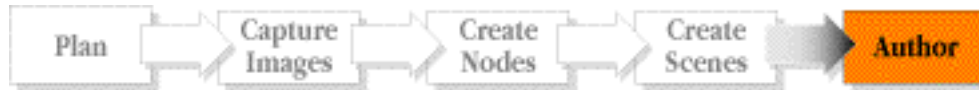
Capture or create the source images for panoramas and/or objects. The tasks here will depend on whether you use photographic, videographic, or computer-generated image technologies. The details of this stage are covered in the QTVR Panoramas and QTVR Objects sections.



Stitch, dice, and assemble each QTVR panorama from individual source images, or assemble individual views for a QTVR object movie. This stage reflects the main computer-based tasks of QTVR production. The details of this stage are covered in the QTVR Panoramas and QTVR Objects sections.



This stage takes the individual QTVR panoramas and objects and links them together into a completed, stand-alone QTVR scene. The details of this stage are the focus of the QTVR Scenes section.



Incorporate the QTVR panoramas, objects, or scenes into a product produced in an authoring environment. This final stage involves using the QTVR files in a multimedia product.

QTVR Panoramas



In the QTVR Overview section, you learned that QTVR panoramas can be created from a variety of source images using almost any camera and lens combination. In this section, you will learn the details of the QTVR development process for panoramas and will explore how to create panoramas from a number of different image sources.



Under the Covers of QTVR Panoramas

Basic terms and capabilities of QTVR panoramas laid bare and open to scrutiny.



Image Capture Approaches

The hows and whys of various image capture approaches for panoramas.



Implications of Capture Approach on the Panorama

How the choice of image capture approach effects the final QTVR panorama.



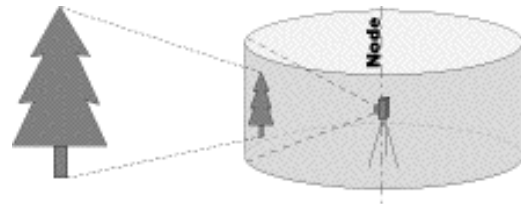
Development Process for Panoramas

The down and dirty details of the panorama creation process, as well as timely tips for efficient panorama production.

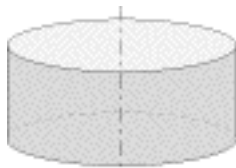
QTVR Panoramas – Under the Covers



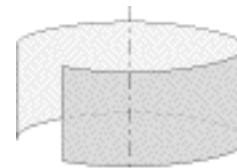
QTVR Panoramas are centered on a single point of observation, called a node. In essence, the view of 3D space from the point of observation is mapped onto a cylindrical image which surrounds the point.



A QTVR panorama can represent either a full or partial horizontal view from the point of observation. Full panoramas encompass a seamless cylinder which allows unrestricted horizontal movement. A certain amount of vertical movement is also possible, limited only by the height of the cylinder. Partial panoramas are a subset of a full panorama as they have only a limited horizontal range of motion.

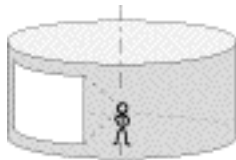


Full Panorama

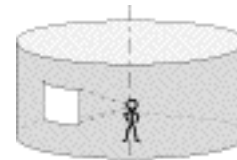


Partial Panorama

From the central observation point (the node), a viewer may zoom into or out from a particular view by changing the **zoom angle** of their view. The zoom angle thus represents the mapping of the cylindrical image into the viewing window on a user's monitor. As a user zooms into a panorama, the viewing window on their monitor remains the same size but shows an increasingly smaller area of the cylindrical image.



Large zoom angle



Small zoom angle

The ability to zoom into the panorama can lead to a user seeing enlarged individual pixels at very small zoom angle settings. For this reason, most developers will set a minimum and/or maximum value for the zoom angle to prevent either too wide an angle of view, or a view that becomes too pixelated.

QTVR Panoramas – Image Capture Approaches

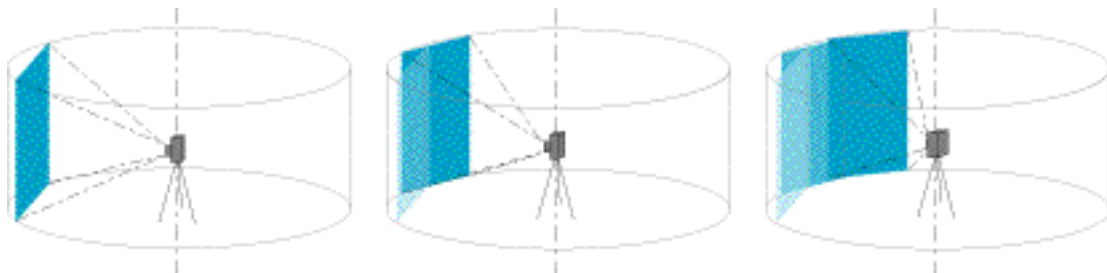


QTVR panoramas can be created using images captured with a variety of cameras, lenses, and films, or even from computer created environments. This flexibility, though, requires that you understand the dynamics and limitations of the capture approach you use. There are four main vehicles for creating source images for a panorama:

- Still Camera and Lens
- Video Camera
- Panoramic Camera
- Computer Generated Source Images

Using a Still Camera and Lens

The most common method of image capture for QTVR panoramas is to capture a series of source images around a single point of rotation, then digitize them into a set of Pict files. These Pict files are then **stitched** together using the QTVR tools to create a single QTVR **panoramic Pict**. The source images can be captured using nearly any type of lens and camera combination, from point and shoot 35mm film cameras to digital cameras to large format cameras.



The three main requirements for this approach are that...

- a) the camera must rotate on an axis perpendicular to the axis of the lens,
- b) the camera must be corrected for **parallax**, and
- c) the lens must produce **rectilinear images** - that is, straight lines in the scene must appear as straight lines in the resulting image.

Thus, wide angle "fish eye" type lenses which create noticeable distortion are not generally suitable for QTVR image capture, unless you plan to re-correct their distortions prior to stitching.

Using a Video Camera

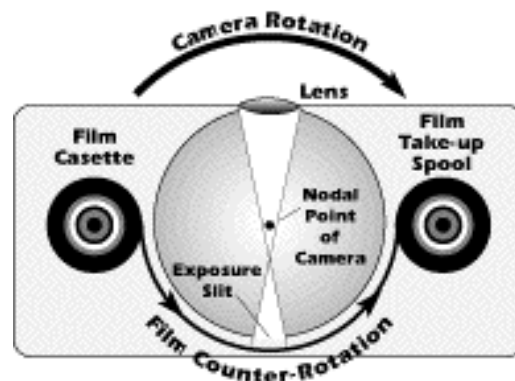
Although normally used to capture images for movies, video cameras can also be used to capture the source images needed for QTVR panoramas. Single video frames can be captured around a pivot point and then digitized into a set of Pict files, similar to those captured with photographic cameras. These Pict files are stitched together just like those captured with still cameras.

This approach is not widely used, however, owing to the generally lower quality of the source images that are produced. Lower quality images result in less zooming capability in the final QTVR panorama. However, for situations where only low resolution panoramas are desired, such as for world wide web pages, a video capture approach may be adequate. The requirements for capturing images with a video camera are identical to those of a still camera and lens, and have the same implications of the image capture approach (covered in next sub-section of this module).

Using a Panoramic Camera

One special type of camera, called a panoramic camera, uses a vertical slit shutter. The camera itself (or the lens, depending on the camera) rotates around a nodal point as the film is advanced.

The resulting image is in fact a cylindrical representation of the view and is normally from 180-380 degrees in width. It extends beyond 360 degrees owing to the extra horizontal field of view at the beginning and end of the camera's rotation. Although these cameras are quite expensive, they produce an image that is equivalent to a stitched panoramic Pict directly on film. These images, once digitized, can also be converted into a QTVR panorama.



For QTVR work, panoramic cameras provide a unique means of capturing a panorama in a location where there is unavoidable movement, such as a busy park or street. They can capture the panoramic image at speeds up to or over 1/250th of a second. This essentially "freezes" moving people, vehicles, or objects in position in the panorama. However, these cameras provide a limited vertical field of view and require manual processing to crop and color match the edges of the panoramic Pict. In addition, digitizing these images can be time-consuming and/or expensive.

Using a Computer-Generated Source

Finally, source images can also be created directly from most 3D computer graphics rendering environments by selecting a point in space in the computer generated scene and rendering the view from that point.



Computer generated 360 degree panoramic image (Image courtesy of David Palermo)

Most such applications allow the developer to specify the equivalent of a camera lens's vertical field of view and generate images that correspond nearly identically to those captured using film or digital capture approaches. Many applications will also generate the equivalent of a single 360 degree panoramic Pict file from the point in space. Either approach can be used to create the final QTVR panorama.

QTVR Panoramas – Implications of Image Capture



The choice of image capture approach has direct implications on several aspects of the resulting QTVR panorama. Some of these affect the user's viewing experience, while some affect your efforts as a developer to create the QTVR panorama itself. The significant implications are:

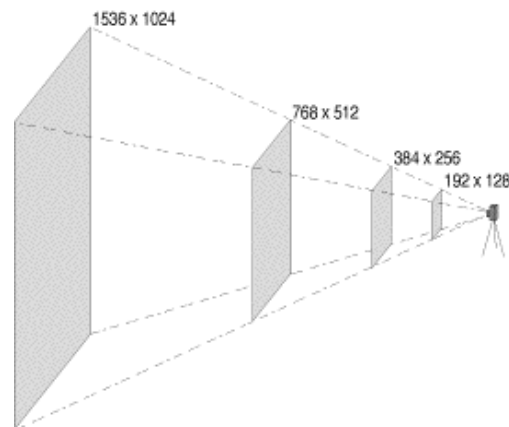
- Choice of source image resolution and the QTVR panorama size and quality
- Choice of lens and the panorama's vertical field of view
- Choice of lens and the size of the cylindrical panoramic Pict
- Leveling the camera before capturing images
- Correcting the camera for **parallax**

Choice of Image Resolution on the Size of the Panorama

Most developers use 35mm film to capture images for a QTVR panorama. Developers using film generally use Kodak's PhotoCD conversion process to digitize the source images from film to a digital format. The PhotoCD process creates five digital images for each negative on a roll of film, all at 72 dpi (dots per inch):

- 192 x 128 pixels
- 384 x 256 pixels
- 768 x 512 pixels
- 1536 x 1024 pixels
- 3072 x 2048 pixels

Although the size of the images (in number of pixels as well as file size) varies greatly, the same view is represented for each negative.

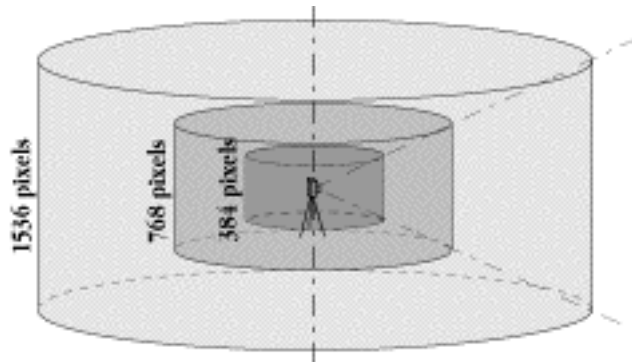


PhotoCD Image Resolutions



For the sake of conserving space in the graphic, only the four lowest resolution levels are represented here.

However, the higher resolutions provide for greater depth of detail in the digital image. To visualize the relationship of the PhotoCD image's resolution size to the size of the QTVR panoramic Pict, imagine that each successive resolution is twice as far from the camera.



Panorama cylinder size relationship to source image resolution

Naturally, as the resolution size increases, the resulting QTVR panoramic Pict's file size also increases. Larger file sizes have two direct implications:

- more hard disk space and RAM memory will be required during development
- for good playback performance, faster machines (especially video bus speed) will be better for the ultimate users

If the source images are digitized using any other process, you should convert them to the standard monitor resolution (72 dpi) before proceeding with QTVR development.



Currently, most QTVR developers use source images at the 768 x 512 resolution. These create final QTVR panoramas in the neighborhood of 500-800 KB in size (depending on the lens) and provide adequate playback performance even on lower end machines. The resulting QTVR panoramic Picts can be downsized in a pixel editing program, such as Adobe Photoshop, to create even smaller versions for playback in environments such as the world wide web.

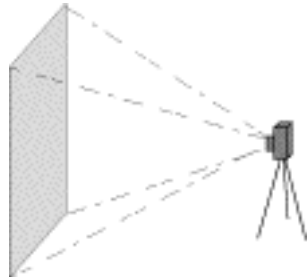
Choice of Lens and the Effect on Vertical Field of View

While it may seem obvious, it is important to note that the ability to pan vertically in the QTVR panorama is limited to the vertical field of view of the lens used to capture the source images. A wide angle lens will let you see a larger vertical field of view; however, it also gives the impression of "pushing" objects in the view farther away.

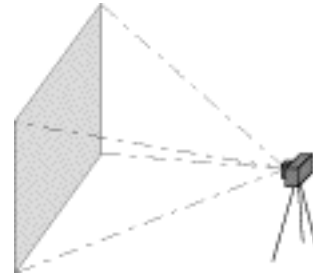


Wider angle lenses make objects appear smaller in the image but provide a greater vertical field of view

Similarly, a 35mm camera positioned in portrait orientation will produce images with greater vertical field of view than those from a camera in landscape orientation due to the aspect ratio of height to width on the captured image. The same holds true for the orientation of a video camera, owing to the 3:4 aspect ratio (height to width) of standard video frames.



Portrait orientation



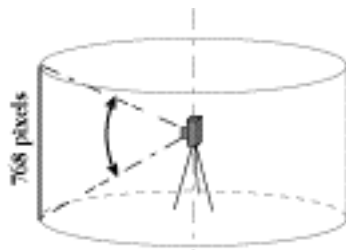
Landscape orientation

Choice of Lens and the Size of the Panoramic Image

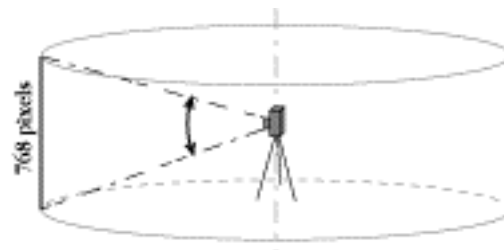
You now know that QTVR panoramas are based on a cylindrical view of 3D space. This fact implies that the choice of lens used to capture source images has a direct impact on the size and shape of the final panoramic Pict. This may not seem evident at first, but it's a great practical application of that geometry you studied in high school.

By using a lens with a greater vertical field of view, the size of the panoramic cylinder will actually decrease. This is due to the fact that the vertical height of the cylinder is the same regardless of the lens used. To verify this, let's compare two lenses: a wide angle 15mm lens, and a less wide angle 28mm lens.

Assume the source images from both the 15mm and 28mm lenses are captured with a camera in a portrait orientation and that the final panoramic Pict is created from images at the mid-sized PhotoCD resolution (768 x 512 pixels). Thus, the panoramic cylinders produced by each lens will both be 768 pixels tall:

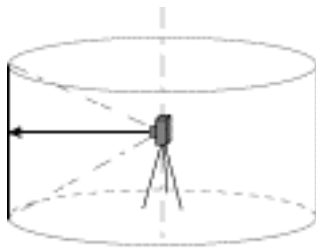


15mm lens cylinder

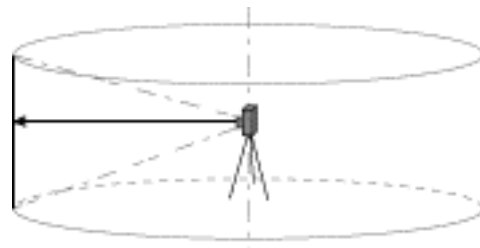


28mm lens cylinder

Since the vertical field of view is greater for the 15mm lens, it will have a shorter radius for the cylinder.



Radius of 15mm lens



Radius of 28mm lens

You can see that the distance around the panoramic cylinder for the 15mm lens will be shorter than that for the 28mm lens. The choice of lens thus has a direct relationship not only to the vertical field of view of the final panorama, but also to the size (i.e., the circumference, or distance around) of the panoramic Pict itself. Wider angle lenses result in smaller panoramic Picts.



This is an important implication for web-based authors who need to keep file sizes small.

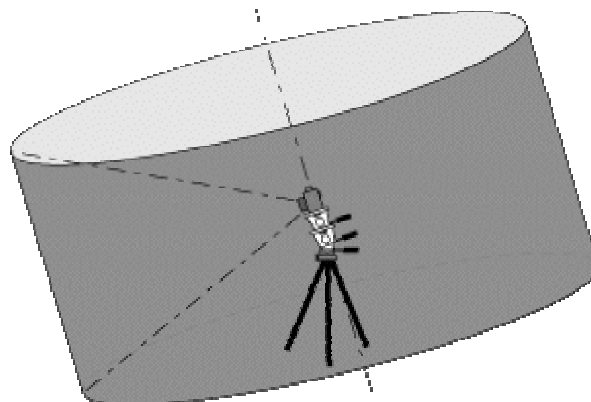
Leveling the Camera

The fact that a QTVR panorama is based on a cylindrical view of 3D space has significant implications for how the source images must be captured. To ensure the best possible panorama, the camera must rotate on an axis that is perpendicular to the axis of the view through the camera's lens.



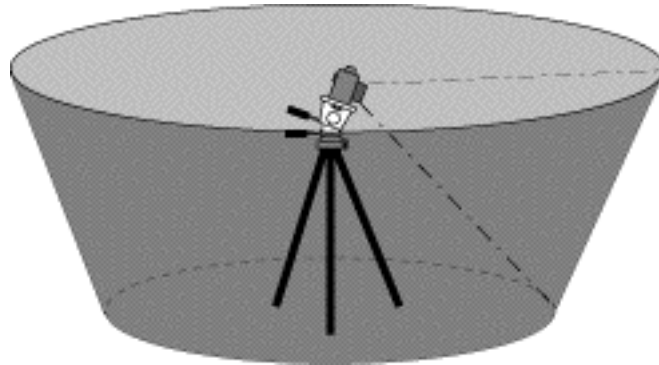
This doesn't mean that the camera must be level with the horizon!

The QTVR development process works beautifully with images captured at an angle, for example, looking up or down a staircase. In these situations you must realize that if you are looking downward at one position in the panorama, you will be looking upward at the point 180 degrees around the panorama.



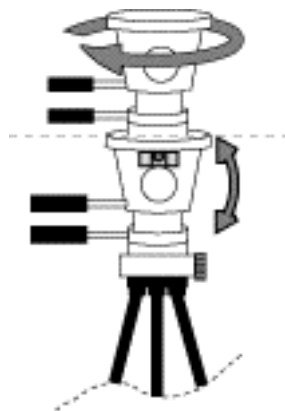
Panorama captured on an angle

However, you cannot simply mount a camera on a typical tripod and tilt the camera on a down- or up-facing angle. If you did so, as you rotated the camera to capture the individual images, you would capture images that would equate to a conic, not cylindrical shape.



Camera tilted on a typical tripod produces a conic shape

Instead, two pan/tilt heads mounted together are recommended for capturing images for QTVR panoramas. The lower head is used to provide a level or tilted surface, while the upper head is used for the rotation of the camera.



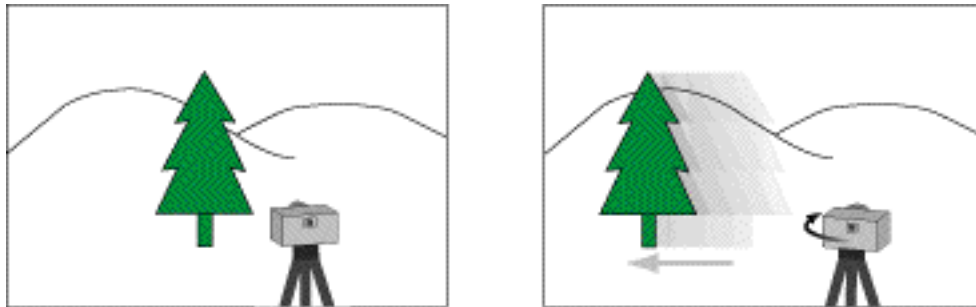
Lower head for level or tilted angles, upper head for rotation



You can acquire this type of off-the-shelf equipment from many professional photography stores. In addition, there are 3rd party suppliers who offer a line of specialty QTVR camera rig products.

Correcting the Camera for Parallax

Just as care must be exercised when leveling the camera, so too must you correct for parallax in the captured images. Parallax results when the focal point (also called the nodal point) of the camera lens is offset from the camera's point of rotation. This offset causes foreground objects to appear to move relative to more distant objects when the camera is panned from side to side.

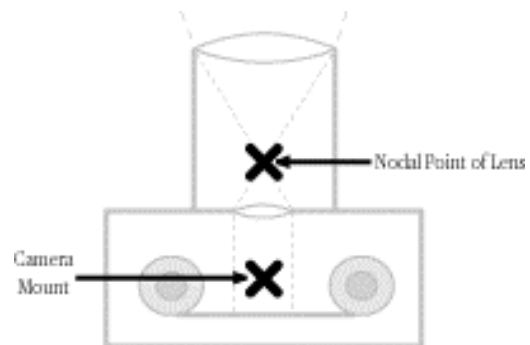


Apparent movement of foreground objects caused by parallax

You can check this for yourself by trying out the following:

- Stand where you can see both nearby and distant objects of landmarks.
- Cover one of your eyes with a piece of paper or your hand.
- Pivot your head, noting any apparent motion of foreground objects in relation to more distant objects.
- This motion is called parallax, and it results from the fact that your point of rotation (the middle of your spine) is not the same as the focal point of your eye.

Parallax occurs when a camera is mounted on a typical tripod. All tripods provide a camera mount which rotates the camera on a point near the camera's film plane. However, the nodal point of the lens (where the image comes into a single point of focus) is normally close to the rear optic of the lens.

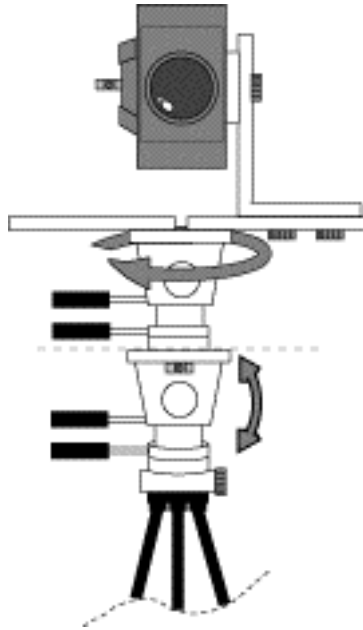


To correct for parallax, the camera must be mounted so it rotates on the nodal point of the lens.

This can

be achieved either with a combination of off-the-shelf photographic gear or by using rigs sold by QTVR vendors.

Either way, the essentials are the same; the camera should be mounted so it rotates around the nodal point of the lens on an axis that is perpendicular to the center of the lens, similar to the graphic below.



Camera rig with upper and lower pan/tilt heads



If all foreground features are relatively distant in the view, then parallax effects are not a problem.

QTVR Panoramas – Development Process



Successful and efficient development of QTVR panoramas requires a certain discipline and understanding of the overall development process. At its most basic level, this process can be divided into three stages. The details for each stage are discussed in the associated sub-section.



During planning the user experience is determined, story boards are produced, panorama specifications are created, and a production timeline and budget are prepared. Planning for QTVR panoramas should address three key points:

- determine the user experience
- create detailed production specifications
- create a development plan and budget

1) Determine The User Experience

In the case of QTVR panoramas, the main aspects that will effect a user's experience are:

- the amount of vertical tilting possible
- the amount of horizontal panning possible
- the amount of zooming into or out of the panorama that is desired
- the actual view that they will have - i.e., the location of the single point of observation

Determining the answers to these questions will allow you to create detailed specifications for each panorama.

2) Create Detailed Production Specifications

Once you have determined how you want users to interact with your panoramas, you can create detailed specifications for the panoramas themselves. Your specifications should address the following:

- location or site plan
- number of panoramas and their location on the site plan
- method of capturing the source images, including the camera and lens, the height of the camera, and the lens orientation (landscape or portrait)
- time of day (or night) for the image capture session
- special considerations for the image capture, such as lighting details or special filters
- number of shots captured around the pivot point for each panorama

3) Create a Development Plan and Budget

Your development plan needs to address four facets: the people, equipment, time, and budget needed to complete your project.

PEOPLE - Developing QTVR panoramas requires a fairly broad range of skills. The chief skills include:

- multimedia development experience
- still photography or scene rendering experience
- videography and video frame capture if using video as a means of capturing images
- graphics editing experience
- experience with using QTVR development tools

EQUIPMENT - The requirements here vary considerably depending on the capture approach used. Typical equipment for photography or video image capture includes either off-the-shelf photographic components or products sold by QTVR rig companies.

You will also need a well equipped computer to efficiently create QTVR panoramas. Although you can use nearly any Power Macintosh with sufficient hard disk space and RAM memory, it is recommended that you use the following when creating panoramas:

- Power Macintosh (any model, though faster CPUs will reduce processing time; an 8500/180 Power Mac requires 5 minutes to stitch images, while a G4 requires only about 2 minutes)
- CD-ROM drive
- 40 MB free RAM (more is always better)
- Mac OS System 7.5.x or higher

TIME - The time required to produce a panorama is more dependent on how long it takes to prepare a site, capture the source images, and digitize them rather than the actual computer-based tasks. For example, you can create a completed QTVR panorama from digitized source images in as little as 10 minutes. However, if the source images have problems and need color correction, air brushing, or other pre- or post-production editing, it could take several hours to complete the panorama.

Thus, your timeline should consider the number of panoramas you'll create as well as an estimate for some image editing. A general estimate for complete development on a per panorama basis could range from 1-3 person/days per panorama from start to finish. This would account in most cases for planning, site preparation, capturing images, digitizing, and creating the final QTVR panorama.

BUDGET - It is difficult to draw any generalizations on a cost per panorama basis, since so much depends on the nature of the panorama itself. For example, a panorama captured from the top of a mountain would definitely cost much more than one taken in your front room simply due to extra travel expenses. In addition, the cost of PhotoCD digitizing in rural areas may differ greatly from providers in larger metropolitan areas. Once you have an understanding of the people and skills required (as well as their hourly rates) and the equipment that will be purchased or rented, you will be able to estimate how much it will cost to complete your project.



During the capture stage, source images for the panoramas are captured or created. The tasks here will depend on whether you use photographic, videographic, or computer-generated image technologies.

Once you've completed the planning process for panoramas, you're ready for the next phase - capturing the source images you'll use to create the panorama. This stage should encompass:

- preparing the site and equipment
- capturing the source images
- capture production tips

1) Preparation and Setup for Panorama Image Capture

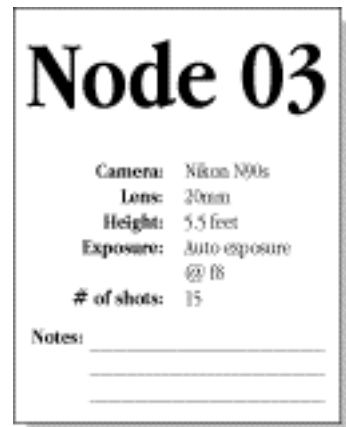
Preparing to capture the source images for a panorama involves three main tasks:

- preparing documentation
- preparing the site
- preparing the image capture equipment

DOCUMENTATION - preparing documentation in advance of capturing images is one of the most overlooked tasks of QTVR production. And, therefore, it is also one of the tasks that is most regretted when it isn't done! This is especially true when you are capturing images for a number of panoramas during the same session. The documentation useful during image capture will simplify not only the image capture process itself, but also the production steps you'll perform many days later as you convert your source images into a completed QTVR panorama.

The documentation tasks should include:

- creating the shot sequence if capturing images for more than one panorama
- creating a title page for each panorama
- labeling film rolls and containers to match the respective panorama number
- preparing a documentation notebook to record special conditions or situations during the shoot



A sample title page for a QTVR node. The page is titled "Node 03" in a large, bold, serif font. Below the title, there is a list of technical specifications: Camera: Nikon N90s, Lens: 20mm, Height: 5.5 feet, Exposure: Auto exposure @ f8, and # of shots: 15. At the bottom of the page, there is a section labeled "Notes:" followed by three horizontal lines for writing.

Sample title page

SITE PREPARATION - Site preparation tasks vary depending on whether you are shooting indoors or out and whether you are capturing a single panorama versus a multi-panorama scene. Site preparation will frequently be the most time-consuming task, especially if you are shooting indoors and must balance lighting from several different sources. When preparing the site, you will mark the position of the camera for each panorama, adjust the lighting in the view, and set up all props and objects that you want users to see.

Site preparation is especially important when capturing images for a sequence of panoramas which will later be incorporated into a single QTVR scene. The lighting should be consistent

for all of the panoramas to ensure that the resulting QTVR scene has a consistent look and feel as a user moves from panorama to panorama.

EQUIPMENT PREPARATION - With documentation in hand and the site prepared, you're ready to set up the image capture equipment. Great care must be taken to ensure that the camera rig is leveled so the camera rotates on an axis perpendicular to the lens' field of view and that the camera is mounted to correct for parallax effects. Accuracy here translates into more efficient and successful processing during later development stages.

Several factors should be addressed when setting up the image capture equipment:

- all rig components should be firmly set in place on stable ground
- the rig must be accurately leveled, ensuring the axis of rotation is perpendicular to the lens field of view
- the camera mount must be adjusted for parallax with horizontal rotation over the nodal point of the lens
- film is loaded, the lens focused, and the exposure set; normally you will use an averaged, manual exposure setting for all views being captured. However, you do not absolutely have to use the same exposure setting for all of the shots in the capture sequence – the stitching process often will correct exposure variations.



Most QTVR developers use negative film over transparency (slide) film due to the greater color response. However, either type of film can be used.

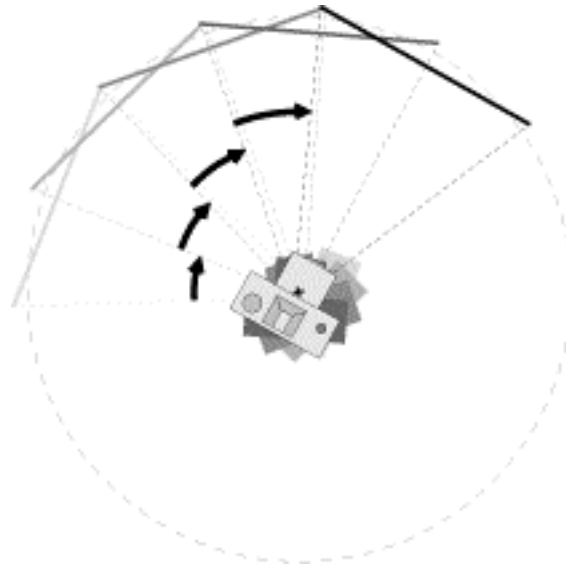
2a) Capturing the Source Images Using 35mm Still Cameras

Once the site is prepared and the equipment assembled, you can capture the source images.

You should:

- take a slate shot of the title page as the first shot of the panorama for ease of later identification
- rotate the camera between shots in a clockwise direction
- rotate the camera with a 50 percent overlap between images
- rotate the camera in a regular arc of consistent angular spacings
- snap images using a shutter release cable to reduce potential camera vibration
- capture the first source image in the sequence in the direction that is least likely to have movement in the view (e.g. people walking) during the shooting sequence

You should capture images with a 50 percent overlap between image pairs. This enables you to create a smooth blend of color values between images during later development steps. This is especially important in outdoor scenes, where colors can change dramatically as you pan into or away from the sun.



Top view of image capture sequence showing rotation direction and consistent angular spacing. Note that there is approximately a 50 percent overlap between image pairs.

Without a 50 percent overlap, the panoramic Pict may contain moderate to severe color banding effects. While banding can be corrected in a program such as Adobe Photoshop, the time and costs of doing so far outweigh the cost of a few extra images per panorama. For example, to capture a full panorama with a 15mm Nikkor lens in portrait orientation, you would shoot 12 shots around at 30 degree intervals to obtain a 50 percent overlap. In contrast, a 24mm Nikkor lens in the same orientation requires 15 shots around at 24 degree intervals. In either case, additional shots would not provide a better final result, while fewer shots may result in banding effects.



When using a lens such as the 24mm, 15 shots around requires the photographer to use a 24 degree rotation between shots. Depending on your gear, it may be easier to simply take 18 shots around using a 20 degree rotation between shots. The extra images will not produce a better panorama, but may be easier to keep the amount of rotation between images consistent.

2b) Capturing Images Using a Video Camera

Capturing images using a video camera should follow the same steps and considerations outlined for 35mm cameras above. You may capture either linear video or still frames, but if capturing linear video you will digitize and save only single frames as individual Pict files. Each of these still frames should be captured in a clockwise direction and image pairs should have a 50 percent overlap using a consistent rotation between them.

Thus, you will not use the video camera to "sweep" the 360 degree view. Instead, you'll rotate the camera, holding it momentarily at one position before rotating again to the next position. Later, you can select an individual frame from each stationary sequence in the video clip to export as the source image for that position.

3) Image Capture Production Tips

A number of practices during the image capture step can simplify your life when creating QTVR panoramas. A sampling includes:

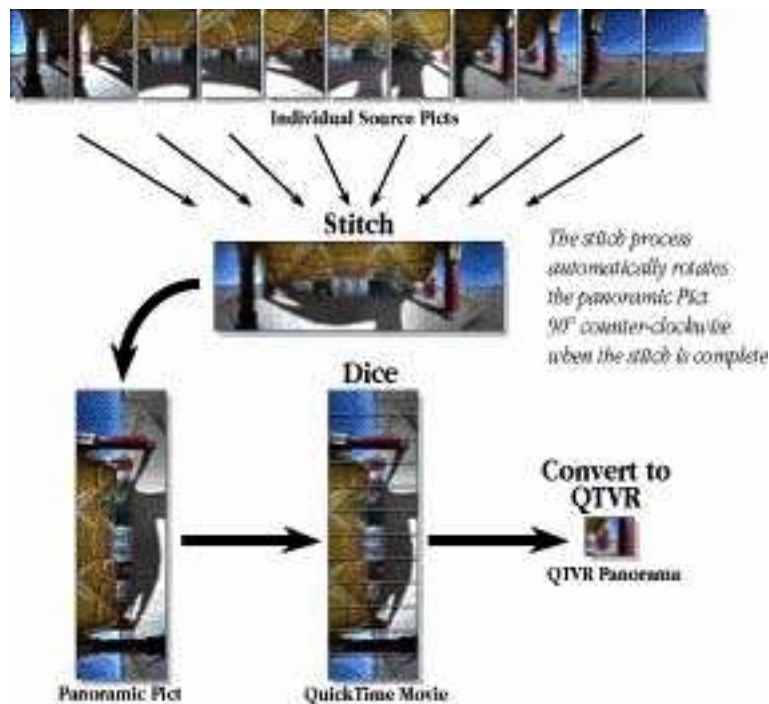
- If you make a mistake, re-take. Film is probably the most inexpensive item in the QTVR panorama development process.
- Consistently number floor plans, panoramas, film cassettes, film cannisters, and production notes.
- Use a consistent process for capturing the images.
- If your images will be digitized using the PhotoCD format, be sure that you get an index print and request that duplication be performed without auto exposure compensation.
- Document the shoot as you go. Be sure to label your negatives in case of digitizing problems.
- Remember, your negatives are your most important asset! Protect them.



When creating the QTVR panorama, the source images are digitized and merged into a single panoramic Pict image using the QTVR tools. The panoramic Pict image is further processed and compressed before being transformed into the final QTVR panorama. This stage reflects the main computer-based tasks of QTVR panorama production.

Creating the final QTVR panorama involves the main computer-based tasks of panorama development, and includes the following steps:

- Digitize the source images
- Stitch the individual source images together to form a single panoramic Pict
- Retouch or edit the panoramic Pict as desired to adjust image or composite additional graphic data
- Convert the panoramic Pict to a QuickTime movie
- Convert the QuickTime movie to a QTVR panorama



The QTVR panorama development process

Digitize the Source Images

You have three main options for converting photographic source Picts to a digitized Pict format:

- have the source negatives (or slides) output in PhotoCD format
- print the negatives (or slides) and scan the prints in a scanner
- use a scanner to digitize from the negatives (or slides) directly

Of the three, the PhotoCD format is often the best choice as it simplifies the storage and retrieval of the digital images and is very efficient for digitizing a high volume of images.

However, any approach which creates acceptable, digitized images in a Pict format can be used to create QTVR panoramas.

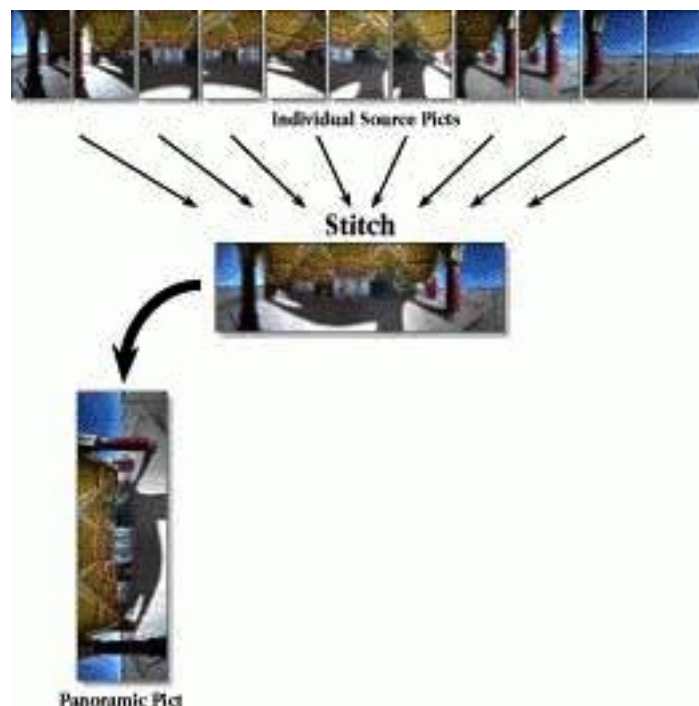


For more information on PhotoCD technology, check out web site.

Creating the Panorama - Stitch the Source Images

The stitching process assembles the individual source Picts and weaves them into a single panoramic Pict image. After the stitch is complete, the panoramic Pict is also rotated 90 degrees counter-clockwise, a step which ultimately improves the playback performance of the completed QTVR panorama. Remember, the panoramic Pict is:

- the representation of a 3-dimensional cylinder, not a cone or sphere
- sized according to the choice of source image resolution and the vertical field of view of the lens used



**Stitching merges individual source images into a single panoramic Pict.
The Pict is then rotated to a vertical orientation.**

The stitching process uses Apple's QTVR Authoring Studio application. Alternatively, other vendors supply authoring tools that can stitch individual source images together.

Retouching the Stitched Pict

The result of the stitching process is a single panoramic Pict file. Since Adobe Photoshop is such a widely used graphics editing program, the stitched Pict is saved automatically with that as the file type creator. There is no special file format to the stitched panoramic Pict - it can be edited just like any other Pict file. However, when creating QTVR panoramas, it is best to exercise care up front during image capture to reduce or eliminate the need to post-process the panoramic Pict itself.

If you must retouch the stitched Pict, keep the following in mind:

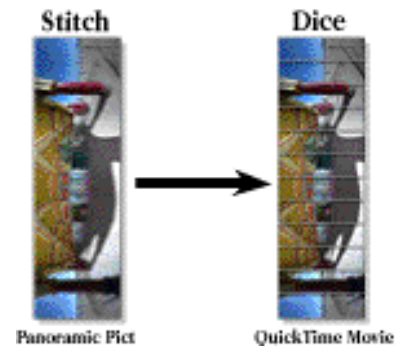
- Use a 32-bit paint program to preserve maximum resolution and color quality
- Use consistent touch ups for all panoramas if you're creating a sequence of panoramas that will later be linked together in a single scene
- Straight lines in the view will no longer be rectilinear – they are warped during the stitching process to accommodate the perspective corrections required to produce the panoramic cylinder
- Always save your work as a new file

Converting the Panoramic Pict to QuickTime

This step converts the panoramic Pict into a QuickTime movie format. The Pict is sliced into a sequence of individual frames, or tiles, with each tile comprising one frame of the resulting QuickTime movie. As part of the conversion, the image is compressed to greatly reduce the file size of the panorama.

For example, a panoramic Pict created from medium-sized PhotoCD resolution images (768 x 512 pixels) results in a panoramic Pict between 5-8 MB in size. After dicing, the QuickTime movie will be only 1/10th-1/20th the size, depending on the compression codec and quality setting used.

This conversion step is automatically performed in the QTVR Authoring Studio application.

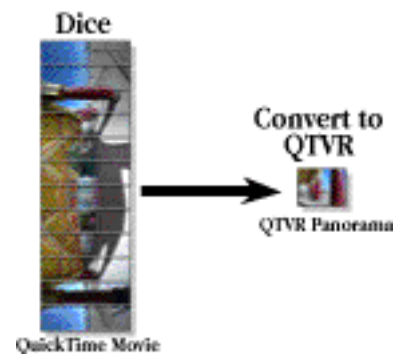


Conversion to QuickTime

Convert to QTVR Format

This final step converts the panorama's QuickTime movie to a QTVR panorama file format which is playable in a QTVR-aware application, in an authored multimedia title, or on a world wide web page.

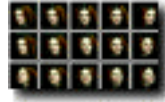
The final conversion step also occurs in the QTVR Authoring Studio. Remember, the individual source Picts are warped so they can be merged together in the stitched panoramic Pict. The panoramic Pict remains warped during both the conversion to QuickTime step and the



Final conversion to a QTVR panorama

final QTVR panorama creation step. It is only when the panorama is being viewed during playback that dewarping occurs and curved lines once again appear straight, just as they are in the original source images.

QTVR Objects



In the QTVR Overview section, you learned that QTVR objects can be created in a number of different forms using a variety of image capture approaches. You also learned the basic capabilities of object movies, such as their pan and tilt characteristics, zoom capability, and how they can incorporate time-based animations. In this chapter, you will learn the details of the QTVR development process for the different types of objects.



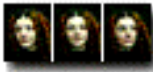
Under the Covers of QTVR Objects

Basic terms and capabilities of QTVR objects opened up like ripe fruit for your enjoyment!



Object Views

The basic composition of QTVR objects as a set of individual views.



Sequencing the Object Views

How the sequence of the individual object views is organized.



Animation Loops and Sequencing

How the views for animated QTVR objects are organized.



Object View States

Creating QTVR objects with multiple viewing states.



QuickTime Essentials

A quick primer on the basics of QuickTime as it affects QTVR objects.



Image Capture for QTVR Objects

Image capture approaches and implications for QTVR objects.



Development Process for Objects

The details of the development process for creating QTVR objects.

QTVR Objects – Under the Covers



Unlike panoramas, which are represented by a single panoramic Pict file, QTVR objects are represented by a sequence of individual, discrete views. Each view is rendered or captured as a single Pict or video frame, but adjoining images are not "stitched" together as happens with QTVR panoramas. Instead, it is the ordered sequence of views which enables QTVR to provide the apparent smooth transitions between the various views.



Ordered sequence of object views

Types of QTVR Object Movies

The basic QTVR object movie generally consists of a number of individual views and can be created with three different kinds of cursors:

- standard drag cursor with edge rotation cursors
- drag-only cursors (no edge rotation cursors)
- joystick cursor (object rotates when mouse is down, dragging increases speed of rotation)

QTVR objects can also contain **animated views**, which play back as continuous loops or as a single animation sequence. Objects can also be **scalable**, allowing the user to zoom into the object for a closer view.

There is a final type of object movie called an **absolute referenced** object. With these movies, it is as if the viewing frame is overlaid with an invisible grid. When the mouse is clicked within the viewing window of the object movie, the position of the cursor within the grid prompts the display of an image associated with that position.

This is perhaps best understood using an example. Imagine you had an object movie of a woman's head that contained 9 total images - a view looking straight into the camera, as well as to the right and left; a view looking straight above the camera, as well as above and to the right and left; and finally a view looking straight down below the camera, as well as below and to the right and left

The collection of images would look like this:



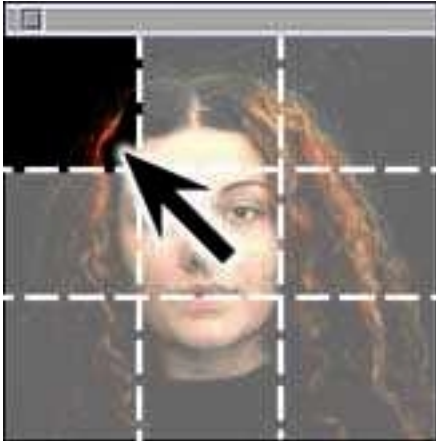
Collection of the QTVR object's 9 images

Since this object contains 9 images laid out in three horizontal views for each of three vertical angles, the invisible grid for this object would reflect that organization and would look like this:



Invisible grid for an absolute referenced object movie of 9 total images, laid out 3 x 3

When a user plays the movie, clicking in the upper right quadrant of the viewing window would cause the image associated with that quadrant (i.e., the view of her looking to the top left) to appear in the window.



A mouse click in this quadrant...



..causes the view to shift to this image



You might have noticed that in the collection of images shown at top above, it appears that the view at the top left of the layout is of the woman looking down and to the left instead of up and to the left. The proper ordered sequence of images for creating absolute referenced objects is presented in the QTVR object view sequence sub-section of this course.

The invisible grid is created automatically based on the number and organization of images in the movie. For example, if we had captured 5 images of the woman's head for each of the three vertical angles, the collection would look like this:



Collection of images for the same object, this time with 15 total images

The invisible grid would look like this:



Invisible grid for an object movie of 15 images, laid out 5 x 3

A mouse click in the middle right of the viewing window would result in this view:



A mouse click in this quadrant...

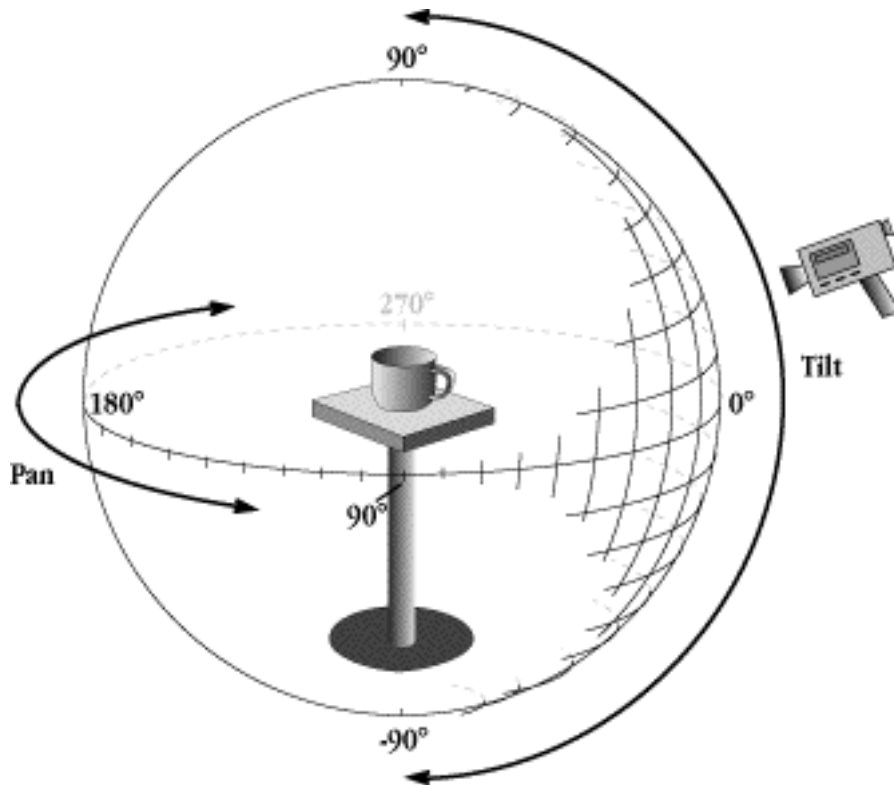


...causes the view to shift to this image

QTVR Objects – Object Views



Perhaps the best way to think about object movies is as a set of individual views taken from the surface of an invisible sphere which surrounds an object. Imagine a consistent coordinate system of points evenly spaced apart around the surface of the sphere similar to the graphic below.



Uniform spacing of points around a sphere



Although this graphic shows images being captured with a video camera, in reality any type of camera can be used to capture source images for objects.

At each junction of coordinates on the surface of the sphere, an image is captured of the object. The vertical position, or tilt, looking directly down on the object would have a 90 degrees vertical angle, while the vertical position looking directly up at the object from below would be a -90 degrees vertical angle. The mid-point vertically (i.e., the equator) would be 0 degrees.

Similarly, at each of the vertical angle positions (tilts) from 90 degrees to -90 degrees, you can imagine a similar sequence of horizontal positions (pans) which would range from 0 degrees to 360 degrees as you progressed around the sphere.



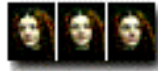
The number of degrees between each of the vertical and horizontal angles is up to you as the developer. It is only recommended that you space both horizontal and vertical angles the same amount. Thus, if you capture images every 15 degrees vertically, you should also capture images every 15 degrees horizontally. This helps ensure that the resulting QTVR object movie has a consistent responsiveness to cursor movement and changes from view to view in any direction in a uniform manner.

A smaller space between horizontal and vertical angles implies that more shots will be required to complete the movie. For example, it would take a total of 684 individual images to represent a full 360 degrees horizontal and 90 degrees to -90 degrees vertical view of an object if shots are taken every 10 degrees (36 horizontal shots at each of the 19 vertical angles). In contrast, it would take 2,664 shots to represent the same object if shots were taken every 5 degrees (72 horizontal shots at each of the 37 vertical angles). Or, it would take only 234 images if shots were taken every 15 degrees.

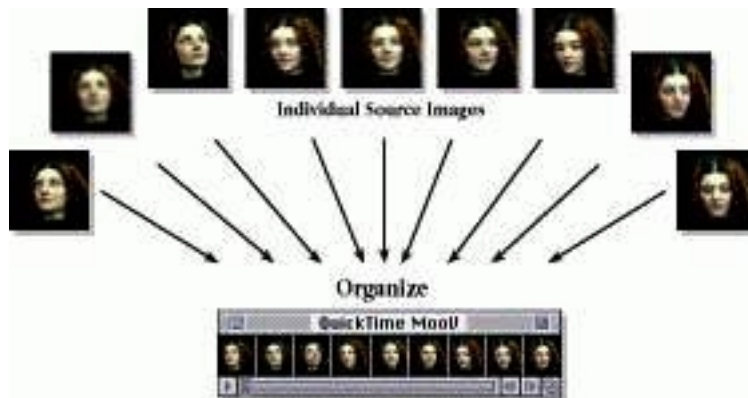


In general, 10 degrees spacings between angles in both horizontal and vertical directions provide a fairly smooth sense of rotation and is a good balance of file size versus smoothness of rotation. Since the number of images to capture has a direct relationship to the final size of the object movie, though, you should experiment with different degree increments for your initial object movies until you get a feel for the file sizes which result.

QTVR Objects – Sequencing Object Views

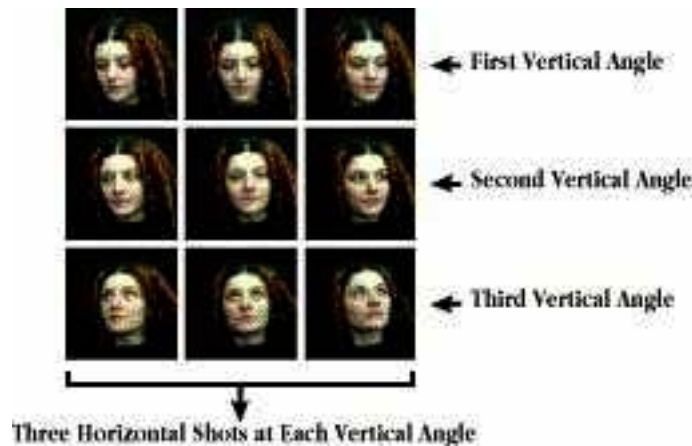


The views captured around an object remain as individual still images. After capture, each individual image is incorporated as a single frame of a linear QuickTime movie. The ordered sequencing of the images is one of the main ingredients to successful QTVR object creation.



Images as individual frames of a QuickTime movie

Imagine again the images of a young woman's face, using three vertical angles and three horizontal positions at each of those vertical angles. You would have a set of images that would look like this:



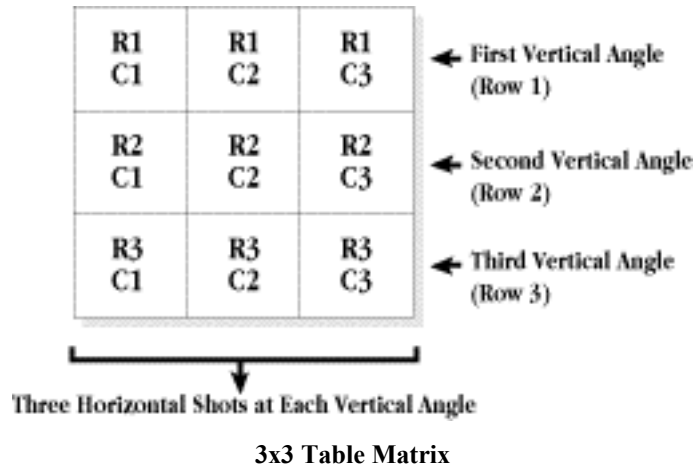
3 horizontal images at each of 3 vertical angles



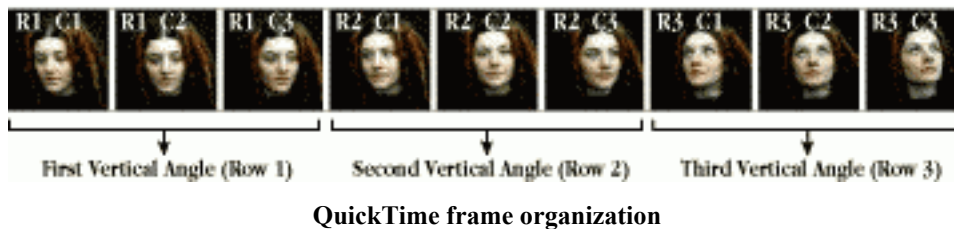
Note that the first vertical angle, being above the "equator," will look down on the woman.

It is helpful to think of an object movie as being represented by a set of images grouped into a table of rows and columns similar to the graphic on the previous page. Each row represents the

shots for a single vertical angle and each column represents the shots at each horizontal position of that vertical angle. An image must be captured for each of the spaces in the table for the object movie to work correctly.



The table of rows and columns is also helpful in understanding the ordered sequence of the images. When creating a QTVR object movie from the images of the woman's head, each image is put into a single frame of a QuickTime movie in the following order:



Thus, you can imagine that each row of the table of images is laid end to end in the linear QuickTime movie, with the top row (i.e., the camera's topmost vertical position) of images being the first set of images in the linear QuickTime movie, followed by the second row, then the third, and so on until you reach the last row.



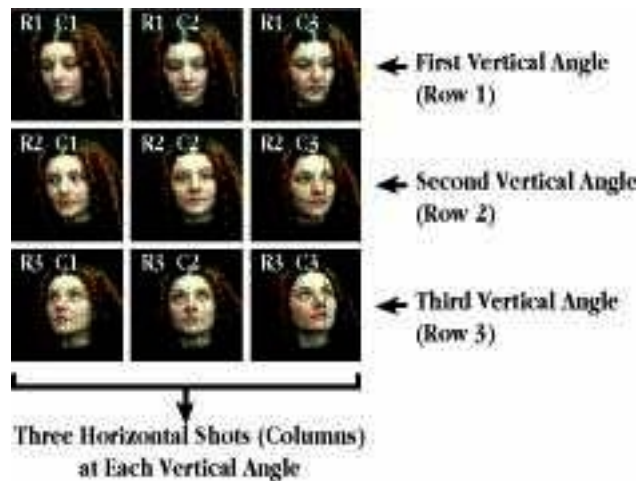
You can lay individual Pict images into the matrix using the QTVR Authoring Studio. Alternatively, several shareware and video editing applications allow you to import Pict images directly into a sequence of frames in a QuickTime movie. Most QTVR developers, however, capture images for object movies using a video camera connected directly to a computer equipped with a digital video board. The QTVR Authoring Studio allows you to capture still frames from the video input source, and the still images are saved directly into subsequent cells in the matrix.

QTVR Objects – Animation Loops and Sequencing



Besides capturing a specific number of horizontal and vertical views, you can also incorporate a sequence of images which will play as an animation at each of the horizontal and vertical positions. Imagine a candle with a flickering flame, a pulsing glow from a pumpkin, or a bird with flapping wings, each of which can be rotated through the sequence of horizontal and vertical views. When the completed QTVR object is manipulated, the animation would play at each horizontal and vertical position, either once through or in a repeating loop.

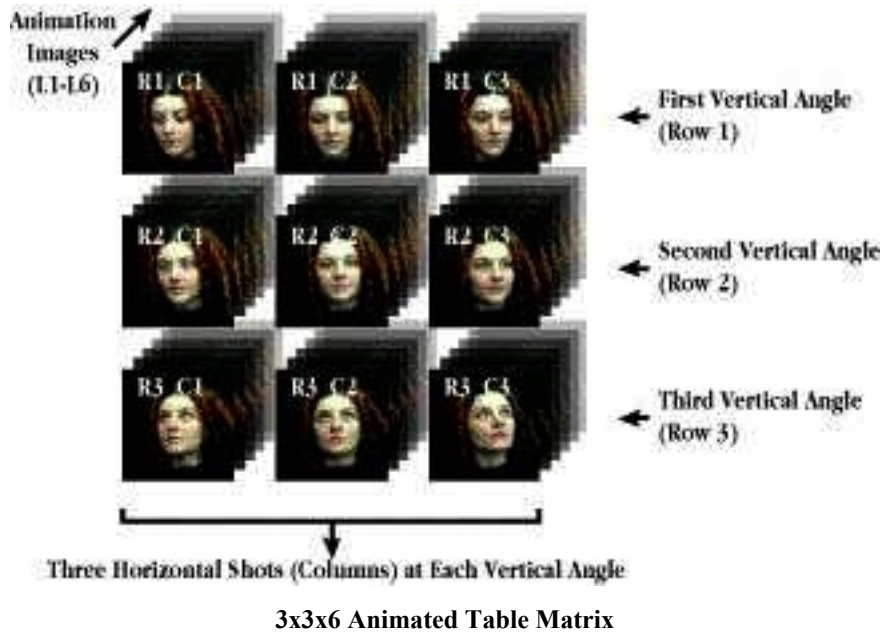
To understand how this would work, assume the young woman's head we studied earlier was slightly animated so that she would occasionally blink as we played the object movie. Regardless of the position we panned or tilted her head, we'd see slight eye and head movement, as if she was actually looking out of the computer display at us. To create such an effect, we'd return to our 3x3 table of images - 3 vertical angles and 3 horizontal views for each vertical angle.



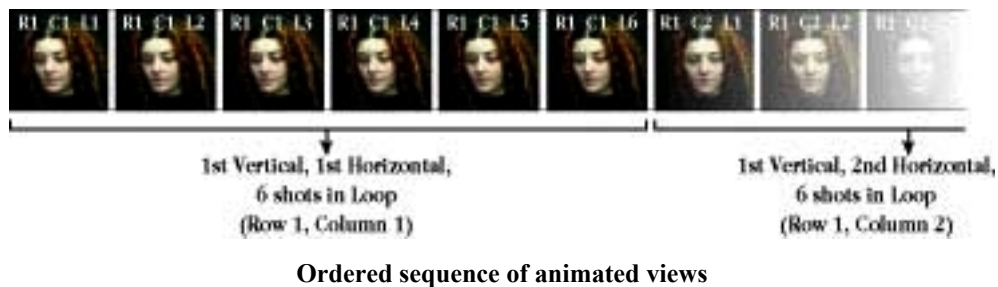
3x3 Table Matrix

Now, however, at each view we would capture a sequence of, say, 6 images. Each of these images would be of her head in the same general orientation, although slight facial and eye movement between shots would provide a sense of animation for the sequence of images.

Thus, we'd end up with a 3 dimensional table, with 3 rows (the vertical angles), 3 columns (the horizontal angles), and a loop of 6 shots at each horizontal/vertical view.

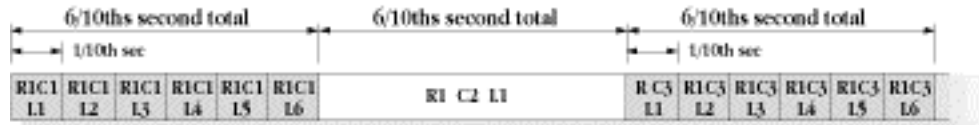


To create the QuickTime movie for this animated object, we'd use a similar layout to our unanimated object. Except that here, we'll include all 6 shots of the loop for each of the horizontal views:



This sequencing would continue with the loops for each of the horizontal views in the first row. At the end of the first row, the next set of images would be the 6 loops for the first horizontal view in the second row (i.e., vertical view), continuing until all images had been assembled into the linear sequence.

Finally, since animation frames are based on a time scale, i.e., a playback rate which stages the animation, it is not absolutely required that each horizontal view have the same number of animation frames in the loop. Instead, only the duration of the loop must be the same for all horizontal views.



The time duration of animation loops must be equal, not the number of frames

For example, say you were making a QTVR object of a laptop computer. When viewed from the front, you wished to have an animation playing on the monitor. However, when viewed from behind, there would be no need for an animation. In this case, you could have a loop of 6 frames playing at 1/10 of a second for those horizontal positions where the animation was visible, and a single loop of 1 frame playing at 6/10ths of a second for those positions where no animation was required.

At every horizontal position, then, you would have a loop with a total time duration of 6/10ths of a second, even though you had a different number of frames for the various loops.

QTVR Objects – Object View States



A final aspect of object movie order and sequence is view states. Essentially, the view states of an object movie relate to specific events that may occur during playback. For example, you could have one view state visible when the mouse button is up and another image visible when the mouse button is pressed.



Mouse up view state



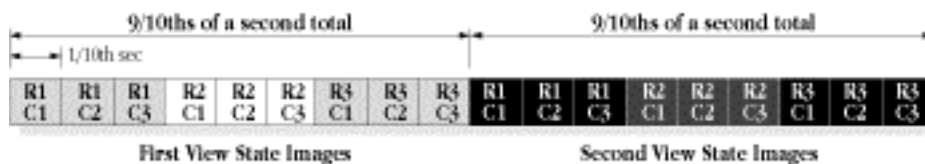
Mouse down view state

You may have as many view states as you wish on a QTVR object movie, although only 2 view states (mouse up and mouse down) are recognized in typical QTVR objects.



Other object view states are accessible only through the QTVR programming API (Application Programming Interface) and thus require a multimedia authoring environment or the C programming language to use.

All of the images for each view state are organized just as for basic object movies. All of the horizontal views for the first vertical angle are sequenced, followed by the horizontal views for the second angle and so on. After all images for the first view state are assembled, the images for the next view state are sequenced and appended to the first view state using the same order sequence. Thus, the sequence of an object movie of our woman's head that has 3 horizontal shots for each of three vertical angles, and two view states would look like this:



QTVR Objects – QuickTime Essentials



As you've no doubt begun to worry, creating QTVR object movies requires a little understanding of QuickTime. While QuickTime is an amazingly powerful technology, you can successfully create QTVR objects when armed with only a little knowledge of its potential. There are several aspects of QuickTime that you should understand:

- QuickTime tracks
- Compression/decompression ("codecs") and quality settings
- Frame size
- Frame playback rates
- Key frames

QuickTime Tracks

A file that is created or saved in a QuickTime format will contain individual tracks for each type of media in the file. For example, a typical digitized video clip normally contains both a sequence of images (the video track) and sound (the audio track). Each of these media types can be processed independently of the other, enabling developers to work with just the audio or the video of a movie.



QuickTime tracks



A QTVR object uses its own unique image track, but a QTVR object can use the standard QuickTime audio, video, and text tracks as well. This implies that you can incorporate audio clips into a QTVR object movie if you desire, provided you understand how to synchronize the clips to play with a given QTVR view duration.

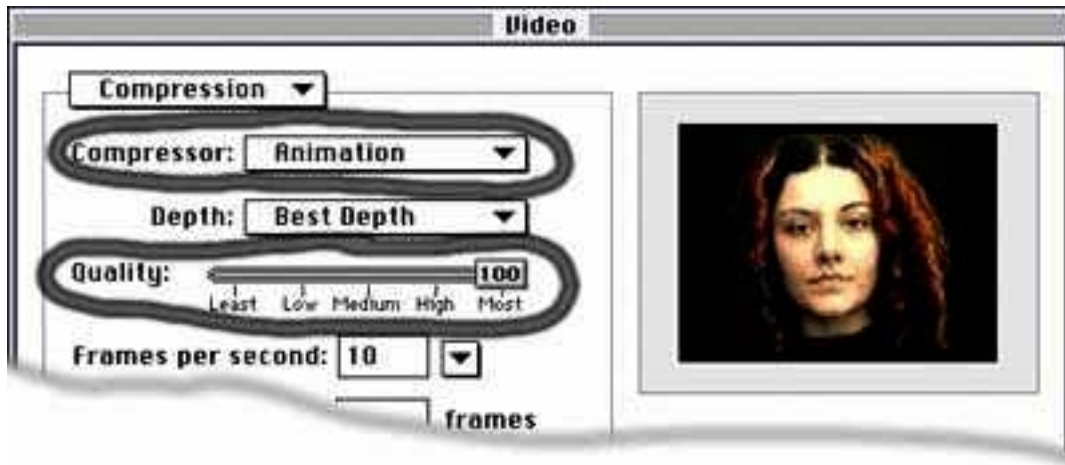
Codecs

Besides the support for different media tracks, QuickTime offers several built-in options for reducing the size of the QuickTime movie file by compressing the audio and video tracks. Compressed movies can be reduced up to nearly 1/100th or less of their original size. When the QuickTime file is opened during playback, the audio/video data is decompressed as it is read into a computer's memory.

The compression/decompression operation, known as the codec, varies according to the type of compression used. Some compressors work better with 8-bit color images, while others work better with 24-bit or higher images. In addition, some compressors use more aggressive routines to compress the images, producing much smaller output files.

Coupled with most compression routines is a quality setting. By selecting different quality levels, you can further reduce the resulting file size of a compressed movie though, again, you also lose

clarity and quality in the images displayed. That is, by reducing the quality, some pixel information will be lost during the compression step - and this information, once lost, cannot be recovered.



QuickTime compression and quality setting

For this reason, if using video to capture your source images for objects, it is recommended to use a lossless compressor, such as the Animation compressor, which can retain the full quality level of the source images. Since this compressor is not very aggressive, the resulting files will normally be quite large. Therefore, most developers capture their source images using Animation, apply any post-production effects or touchups, and then perform a final compression using a more aggressive compressor such as Cinepak or Video which will significantly reduce the size of the output movie file.

Frame Size

The size of QTVR objects is mostly affected by the number of horizontal and vertical views captured, the type of QuickTime compression and quality setting used, and the size of the viewing frame. As mentioned earlier, an object with images captured every 5 degrees could have up to 2,664 images if all possible views were captured. In contrast, an object with images captured every 10 degrees would have only 684 images, or about only 1/4 as many. The resulting file size would also be around 1/4 as big for the 10 degrees object versus the 5 degrees object.

Similarly, the size of the viewing frame directly affects the size of the QTVR object's file. An object captured with a standard 1/4 screen viewing frame (320 pixels by 240 pixels) will be 1/4th as large as an object movie captured with a full screen frame (640 pixels by 480 pixels).



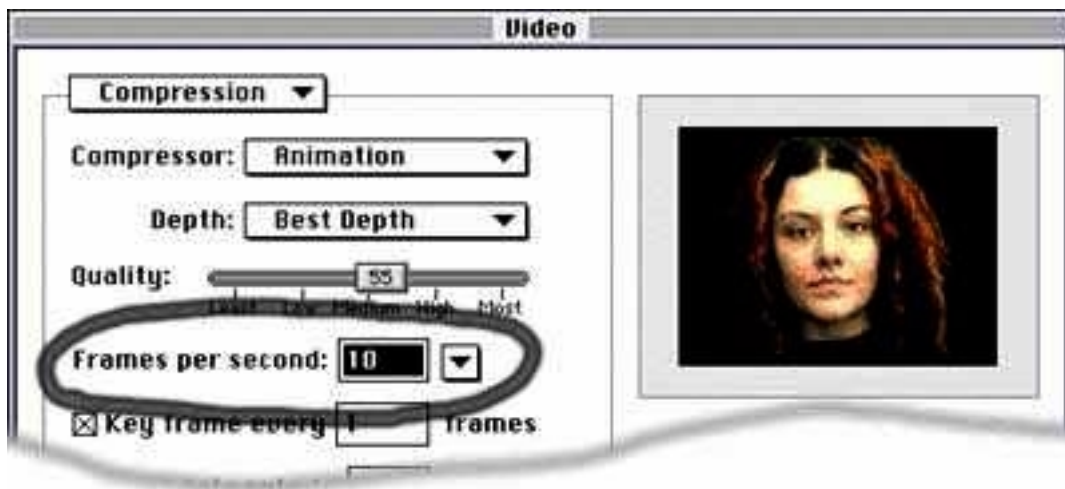
Full vs. 1/4 screen frame size



If capturing images using a direct video connection, the frame size is specified in various ways depending on the video digitizing software used.

Frame Playback Rate

Since QuickTime is intended primarily for playback of time-based media, such as video or sound, every QuickTime movie is created with a frame rate setting. However, the playback frame rate only applies to QTVR object movies that have an animated loop. If the object movie does not have a loop, then any frame rate can be used when assembling the images into the QuickTime format.



Frame playback rate

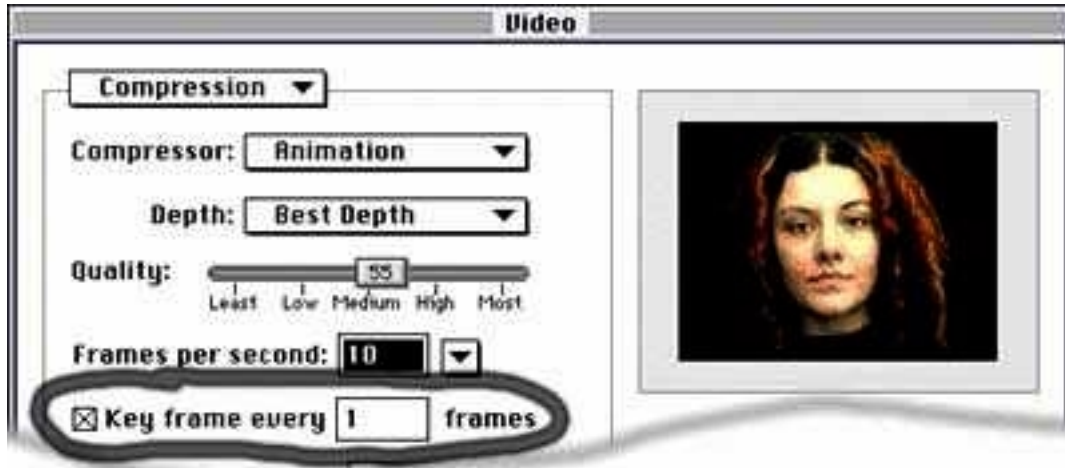
If the object movie does have animated loops, then a frame rate setting should be selected that provides for smooth playback of the frames in the loop.



Most QTVR objects are created using either 10 or 12 frames per second as the standard playback rate.

Key Frames

In addition to the frame playback rate, QuickTime allows you to specify a key frame setting for a movie. In typical video clips, key frames are set to ensure that audio and video tracks stay synchronized even on low end platforms. During playback, if the display of the video image frames starts to lag behind the audio, then individual frames of the video are skipped and are not displayed, allowing the audio and video tracks to synchronize at the key frames.



Key frame setting for QTVR objects

The key frame setting effects how most codecs compression the video data in the movie. Between the key frames, most codecs will employ frame differencing (also called temporal compression) which allows it to greatly reduce the file size by dealing only with the information that changes from the previous frame. All pixels that have not changed are simply left blank (i.e., transparent).

While this is an effective technique for linear video, for QTVR objects the results can be disastrous. During playback, a user might go from any view to any other view, and thus might not pass through a key frame which contains the complete video data. Thus, QTVR objects are created with every frame set as a key frame, i.e., the key frames for the object is set to 1. This enables the QTVR playback engine to display a complete view of the object at each frame as a user pans with the cursor, regardless of the image's position in the movie's frame sequence.

QTVR Objects – Image Capture for Objects



As you know, you can use a variety of image capture approaches to create QTVR object movies. Still photography, video cameras, or even 3D rendering applications can all capture or generate the images needed to create a QTVR object. However, your choice of capture approach has implications for the quality of your movie as well as the process you'll use to create it.

Consider again the number of images required to create an object movie if you capture images every 10 degrees horizontally and use 14 vertical views, from 90 degrees to -40 degrees. You will capture a total of 504 images to create the movie (14 times 36 = 504), assuming that there are no animated views.

If you were to use a still 35mm camera to capture the images, you would need 14 rolls of 36-exposure film to capture all the images for the single QTVR object. When you consider the costs for film and digitizing, you could easily approach \$700 for materials alone, not counting your own time for capturing or pre-/post-processing the images. In contrast, if you use a video camera and a digitizing board to capture the images, your material costs are \$0 as the individual images are digitized as they are captured and no film development or digitizing is needed.

In addition, using a video camera to capture your images enables you to load the views directly into a QuickTime movie, saving an entire processing step over using film. Imagine the time required to organize and properly sequence ± 500 digital images into the correct order and then load them into a QuickTime movie.

For the above reasons, most developers use video capture methods when creating QTVR objects. It is generally easier, faster, and more convenient, especially for objects requiring a large number of views or a large number of animated loops. However, using film or digital 35mm cameras does have its place. Because QTVR objects also support zooming, the higher resolutions provided by 35mm film images allow users to see more detail as they zoom into the object. Thus, your choice of a capture approach will be a trade-off between the image resolution desired for zooming, the desired size of the object file, and the number of views you intend to capture.

QTVR Objects – Development Process



Successful and efficient development of QTVR objects requires a certain discipline and understanding of the overall development process. At its most basic level, this process can be divided into three stages:



During planning, the user experience is determined, story boards are produced, object specifications are created, and a production timeline and budget are prepared. Planning for QTVR objects should address three key points:

- Determine the user experience
- Create detailed production specifications
- Create a development plan and budget

1) Determine The User Experience

In the case of QTVR objects, the main aspects that will effect a user's experience are:

- the look and feel of the object manipulation, including the amount of vertical tilting and horizontal panning desired as well as the type of cursor to use, the amount of zooming into or out of the object, and the use of any time-based loops and how they should work during play back
- the background for the object
- the quality level of the image

Determining the answers to these questions will allow you to create detailed specifications for each panorama.

2) Creating Detailed Production Specifications

Once you have determined how you want users to interact with your objects, you can create their detailed specifications. The specifications should address the following:

- method of capturing the source images
- the number of horizontal/vertical views and number of frames in the loop at each horizontal/vertical view
- special considerations for the image capture, such as lighting details, background, or special filters
- frame size and QuickTime compression/quality settings
- use of audio tracks

3) Create a Development Plan and Budget

Your development plan needs to address four facets: the people, equipment, time, and budget needed to complete your project.

PEOPLE - Developing QTVR objects requires a fairly broad range of skills. The chief skills include:

- Multimedia development experience, especially with creating QuickTime movies
- Still photography or scene rendering experience
- Videography and video frame capture if using video as a means of capturing images
- Graphics (still and/or video) editing experience

EQUIPMENT - The requirements here vary considerably depending on the capture approach used. Typical equipment for photography or video image capture includes either home-built object capture rigs, off-the-shelf photographic components or products sold by QTVR rig companies.

You will also need a fairly well equipped computer to efficiently create QTVR objects, especially if performing any large-scale video editing. Although you can use nearly any Macintosh with sufficient hard disk space and RAM memory, it is recommended that you use the following when creating objects:

- Power Macintosh (nearly any model, though faster CPUs will reduce processing time)
- CD-ROM drive
- 20 MB RAM (more is always better)
- Mac OS System 7.5 or higher

TIME - The time required to produce an object is more dependent on how long it takes to capture the source images and digitize them rather than the actual computer-based tasks. For example, you can create a completed QTVR object from digitized source images in as little as 2 minutes. However, if the source images have problems and need color correction, air brushing, or other pre- or post-production editing, it could take several hours to complete the object movie.

Thus, your timeline should consider the number of objects you'll create as well as an estimate for some image editing. A general estimate for complete development on a per object basis could range from 1/2-2 person/days per object from start to finish. This would account in most cases for planning, object preparation, capturing images, post-production, and creating the final QTVR object.

BUDGET - The cost of creating QTVR object movies on a per object basis depends on the kind of object, the number of shots desired, the type of background used, and other special effects, such as video compositing, that you may wish to perform. Once you have an understanding of the people and skills required (as well as their hourly rates), and the equipment that will be purchased or rented, you will be able to estimate how much it will cost to complete your project.



During image capture, the source images for the objects are captured or created. The tasks here will depend on whether you use photographic, videographic, or computer-generated image technologies.

Once you've completed the planning process for objects, you're ready for the next phase - capturing the source images you'll use to create the QTVR object movie. This stage should encompass preparing the object and equipment as well as capturing the source images themselves.

Preparation and Setup for Object Image Capture

Preparing to capture the source images for objects involves three main tasks:

- preparing documentation
- preparing the object
- preparing the image capture equipment

DOCUMENTATION - The documentation tasks for QTVR objects should include:

- identifying the types of backgrounds and files required for any video compositing
- preparing a documentation notebook to record special conditions or situations during the shoot

OBJECT PREPARATION - Object preparation tasks vary depending on whether you are shooting an object in a studio or in a less controllable setting, such as an outdoor sculpture garden. Preparing the object will frequently be the most time-consuming task of creating QTVR object movies.

When capturing images for large objects outdoors you will mark the position of the camera for each of the shots and where possible adjust the overall lighting for the views. Shooting objects outdoors is perhaps the most challenging type of QTVR object assignment, as creating consistent lighting for all shots can be very difficult. In addition, accurate registration of the camera setup points and consistent distances between each shot will directly reflect how smoothly the final QTVR object movie rotates .

For indoor or studio capture situation, your tasks will involve preparing the object, dampening any highly reflective surfaces, and stabilizing the object on some sort of elevated platform so the object can be rotated between each image.

EQUIPMENT PREPARATION - Preparing the image capture equipment is relatively straightforward for objects. The camera should be setup on a sturdy tripod. If capturing images using still photography, you should have enough film loaded to last for the entire shoot so you won't disturb the camera. If using video, be sure you have adequate video tape or, if digitizing directly as you capture, verify that you have adequate hard disk space to hold the resulting images. This is especially important when capturing images at larger frame sizes, or when capturing extensive shots for looping object movies.

Capturing the Source Images

Once the object, site, and equipment are prepared, you can capture the source images. You should:

- Capture the individual shots starting at the topmost vertical angle; then capture all horizontal shots for that vertical angle. If also capturing a sequence of animated views, capture the images of the animation for each horizontal position before proceeding to the next horizontal view.
- When all horizontal (and animation) shots are captured for the first vertical angle, move to the next vertical angle and continue capturing all horizontal shots from that angle.
- Capture the individual shots with the object rotating clockwise relative to the camera; thus, if rotating the object in front of a static camera, the object should rotate clockwise. If rotating the camera around a static object, the shots should be taken in a counter-clockwise sequence.
- Capture the individual shots with a consistent number of degrees of rotation between each image, in both horizontal and vertical dimensions.

Image Capture Production Tips

A number of practices during the image capture step can simplify your life when creating QTVR objects. A sampling includes:

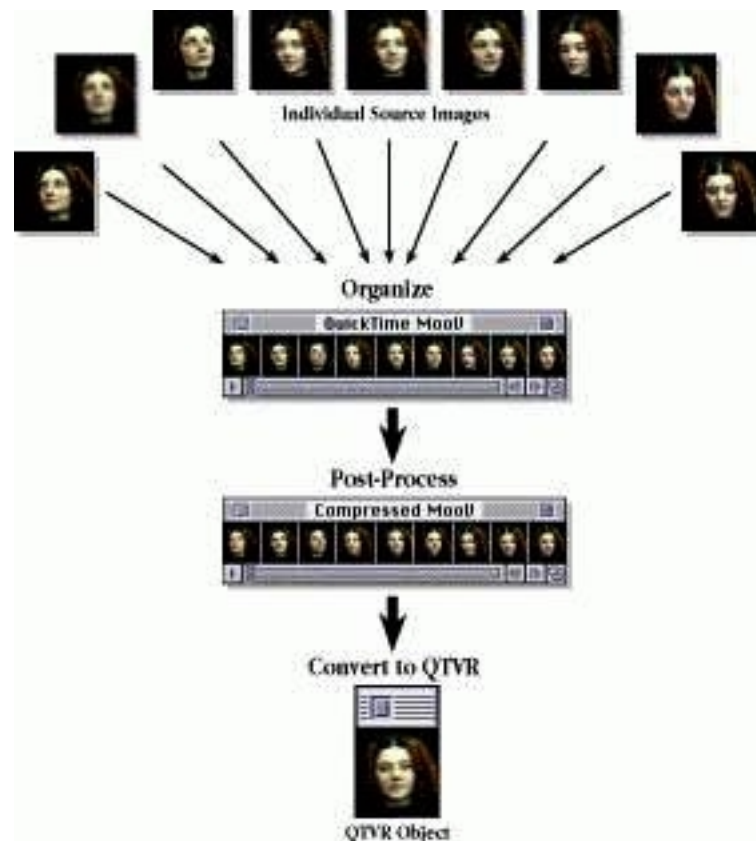
- If you make a mistake, re-take. Since the object preparation step is the most time consuming, restarting the image capture or capturing a few additional shots is much cheaper than capturing images again later.
- Consistently name and/or number the film cannisters or digital files created for your objects.
- Use a consistent process for capturing the images.
- Document the shoot as you go.



When creating the object, the source images are digitized and organized in the proper sequence frame-by-frame in a QuickTime movie format. The QuickTime movie may be further processed and compressed before conversion into the final QTVR object. This stage contains the main computer-based tasks of QTVR object creation.

Creating the final QTVR object involves the following development tasks:

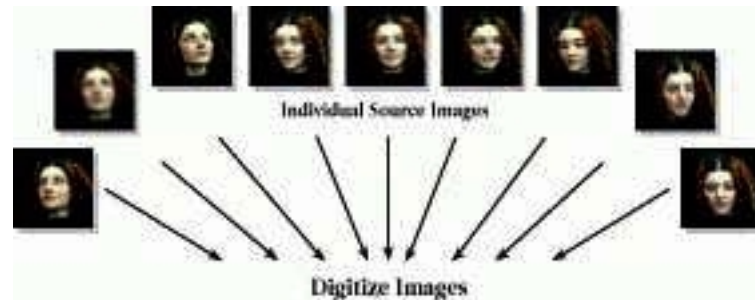
- Digitize the source images
- Pre-process the individual source images to correct initial color balance or frame centering
- Organize the images into the proper sequence and convert if necessary to a QuickTime movie format
- Post-process the QuickTime movie to adjust color, sizing, compression/quality settings, and file size
- Convert the QuickTime movie to a QTVR object



Digitize the Source Images

If you have used a video camera connected directly to a computer video digitizing board, this step is done automatically. However, if you've captured images using videotape or still photography, you will need to digitize the images. You have three main options for converting photographic source images to a digitized Pict format:

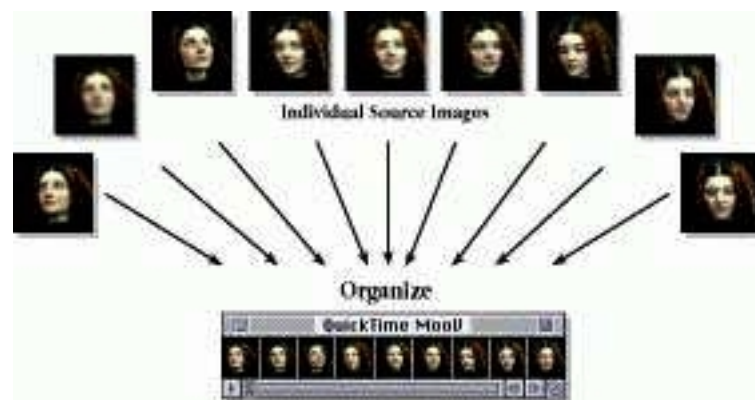
- have the source negatives digitized in PhotoCD format
- print the negatives and scan the prints in a scanner
- use a scanner to digitize from the negatives directly



Creating QTVR Objects - Preprocess the Source Images

Since the image capture step may produce a number of individual source images, frequently there are only one or two images in a sequence that need some retouching. For example, a flare or reflection at one view may have changed the color of the object at that shot. This pre-processing step, then, is purely optional and allows you to correct only individual images. If all images need a consistent form of correction, such as balancing the black level of the background or globally resizing the frames, you should perform these operations during the post-processing step, after the images have been organized into a single QuickTime movie.

Creating QTVR Objects - Organize the Source Images



If you have captured the source images directly to digital using a digitizing board, the images are usually automatically saved in this format. The organization of the images should follow the instructions you studied earlier, with all horizontal images for the first vertical angle positioned first, followed by the horizontal images for the second vertical angle, then the third, and so on until all images have been organized into the proper sequence.

If the object movie has multiple view states, then the sequence of images for the second view state is placed after all of the images for the first view state. These are followed by the images for the third and any subsequent view states for the object.

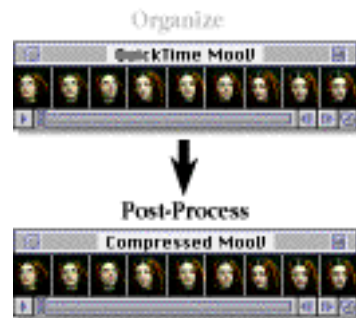


Using the QTVR Authoring Studio, you can either add a group of images to the object's matrix at the same time, or you can add individual images to specified cells in the matrix.

Creating QTVR Objects - Postprocess the QuickTime Movie

Once your images have been loaded into the proper frame sequence of a QuickTime movie, you are ready to adjust the entire movie using a video editing application, such as Adobe Premier, Adobe After Effects, or Avid Videoshop. There are two ways to produce this QuickTime movie:

- Use 3rd party applications to create the QuickTime movie after importing the individual views
- Use the QTVR Authoring Studio to organize the images into the cells of the object's matrix, then create the QuickTime movie from the individual views



In a video editing application, the QuickTime frames can be

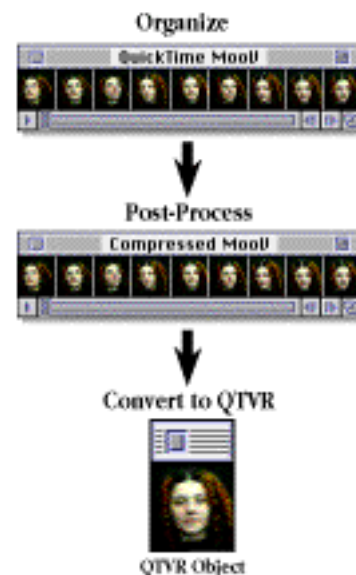
filtered or adjusted uniformly, and different compression/quality settings can be used to experiment with the size and quality of the final QuickTime movie. By creating several versions of the object's QuickTime movie, you can determine the best combination of settings which balance your requirements for image quality and the final file size of the movie.

Creating QTVR Objects - Create the Final QTVR Object

This step converts the object's QuickTime movie to a QTVR format. The completed object movie is created, ready for playback in any QTVR-aware application, in an authored multimedia title, or on the world wide web.

Creating the object occurs in the QTVR Authoring Studio, where you will specify:

- the object type (and type of cursor)
- the duration of the frames in the object's movie
- the number of vertical and horizontal positions
- the number of view states
- >the animation specification for any animated views
- the scalability setting and scaling factors
- the compression/quality setting
- the poster view position

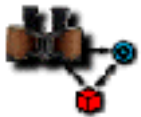


All specifications can later be edited if necessary to adjust the various settings.

QTVR Scenes



In the sections on QTVR Panoramas and Objects, you learned how to create panoramas and objects as stand-alone files. In this section, you'll explore the process for linking individual panoramas and objects together to create a self-contained QTVR scene. This section assumes you understand the basics of the development process for both panoramas objects. If you have not gone through those sections, you should do so before going on.



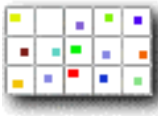
Under the Covers of QTVR Scenes

Basic terms and capabilities of QTVR scenes exposed to the seering wind of reason.



Hot Spots on Panoramas

The hefty details of incorporating hot spots into single, stand-alone QTVR panoramas.



Hot Spots on Objects

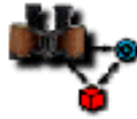
The even more weighty details of incorporating hot spots into a QTVR object.



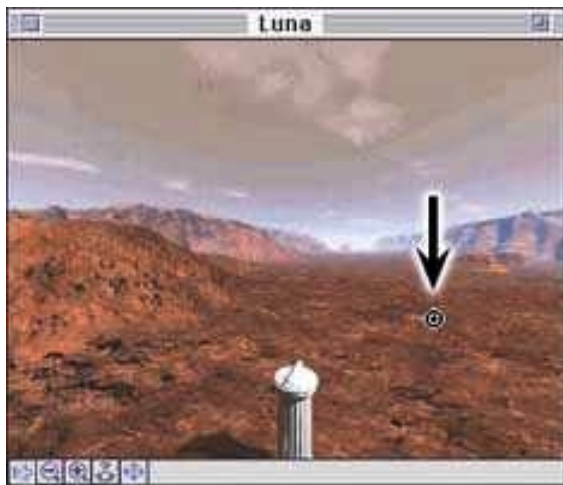
Development Process for Scenes

The monumental details of the development process for creating scenes, along with a master plan of the process that you'll treasure forever.

QTVR Scenes – Under the Covers



By now you're probably familiar with the details of creating QTVR panoramas and objects as stand-alone files. In comparison, QTVR scenes essentially focus on linking those individual files together to create a self-contained group of QTVR component files. In a QTVR scene, you can move from one panorama to another by clicking on a "hot" area of the panorama.

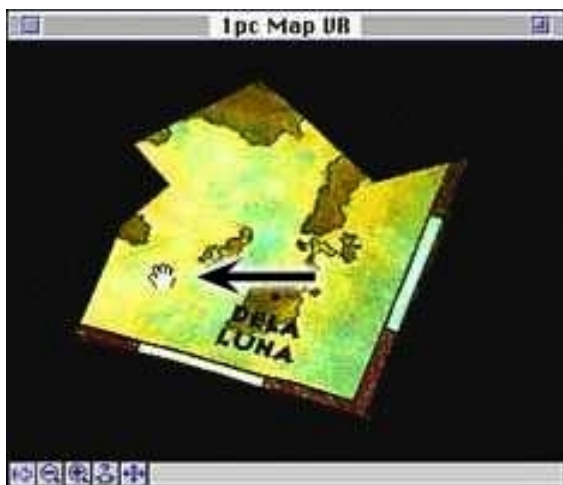


Normal panorama cursor

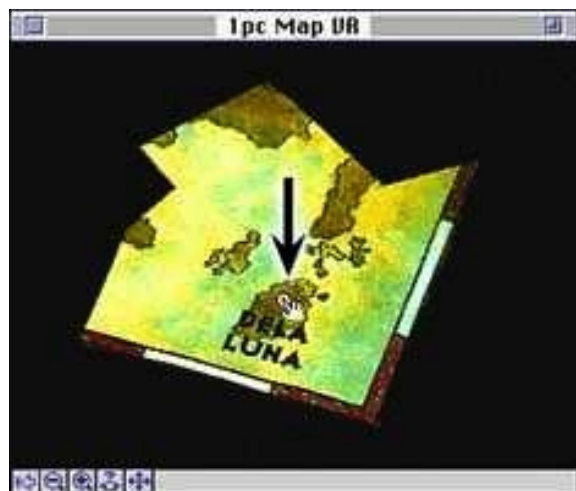


Cursor over a hot spot area

The hot area is revealed to a user by a change in the cursor. If the user clicks on the hot area, their view is shifted to the QTVR panorama, QTVR object, URL, or other media that is the destination of the link. QTVR objects can also contain hot spots, enabling you to similarly link them to panoramas, other objects, URLs, or other media.



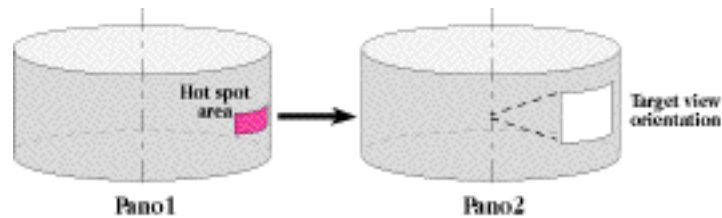
Normal object cursor



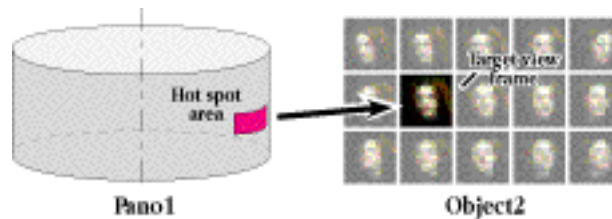
Cursor over a hot spot area

As part of the scene creation process, each link is defined with a target node (i.e., panorama or object) and a specified row/column view (object) or horizontal/vertical orientation (panoramas).

A mouse click in the hot spot area of Pano1 shifts the user's view to...

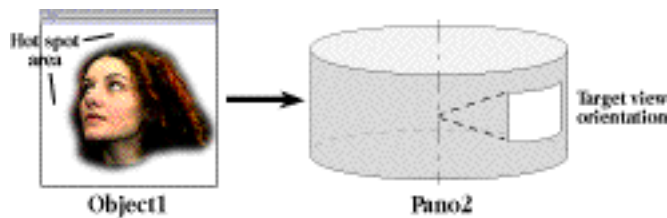


...a specified orientation of Pano2, or...

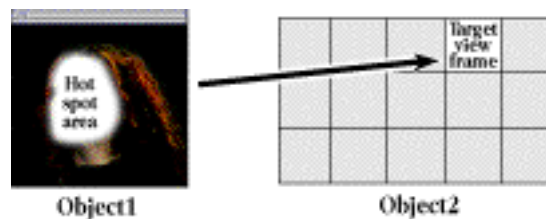


...a specified view frame of Object2.

A mouse click in the hot spot area of Object1 shifts the user's view to...



...a specified orientation of Pano2, or...



...a specified view frame of Object2

Once all links and link specifications are defined, the final QTVR scene file is created. This file contains all QTVR panoramas and objects in a self-contained file that plays as a stand-alone project with any QTVR-aware application, or can be incorporated into a world wide web page or a multimedia authoring environment that recognizes the QTVR API (Application Programming Interface).

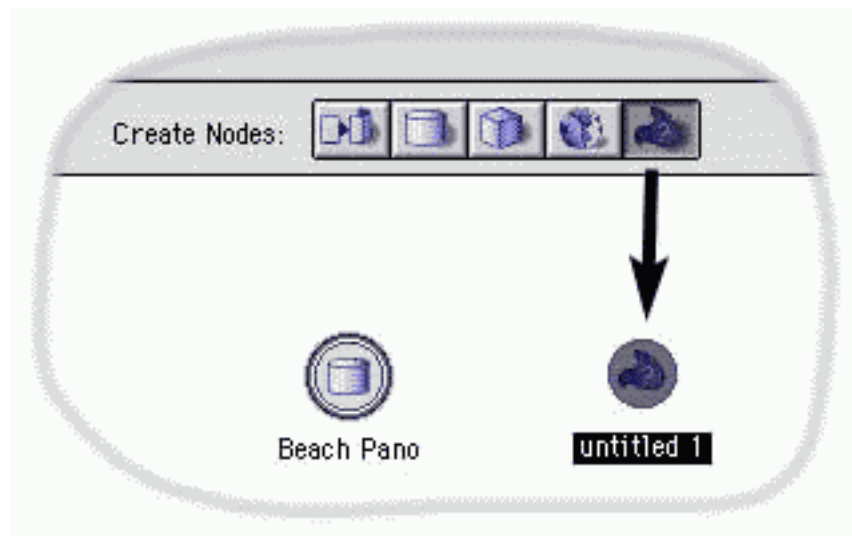
QTVR Scenes – Hot Spots on Panoramas



Since scenes can be fairly large in terms of file size, single panoramas with hot spots are normally only used on a web page to provide links to other web sites, or to other QTVR media on separate web pages. Another use for single panoramas, however, is within a multimedia authoring environment where the hot spots can be used to initiate actions such as play sounds, show a movie, or reveal hidden text.

Thus, creating hot spots on a panorama does not involve a specific target panorama or object, but rather just an undefined hot spot area that provides the cursor change. Instead of defining the link within the panorama, the fact that a user clicks on the hot spot is interpreted by either the multimedia authoring tool or the browser plug-in to execute the link action.

To create hot spots in a QTVR panorama, you'll use the QTVR Authoring Studio's Scene Maker tool. However, since you want only a single panorama with hot spots, you'll use a special node called a "Blob" node to provide an undefined destination for the link.

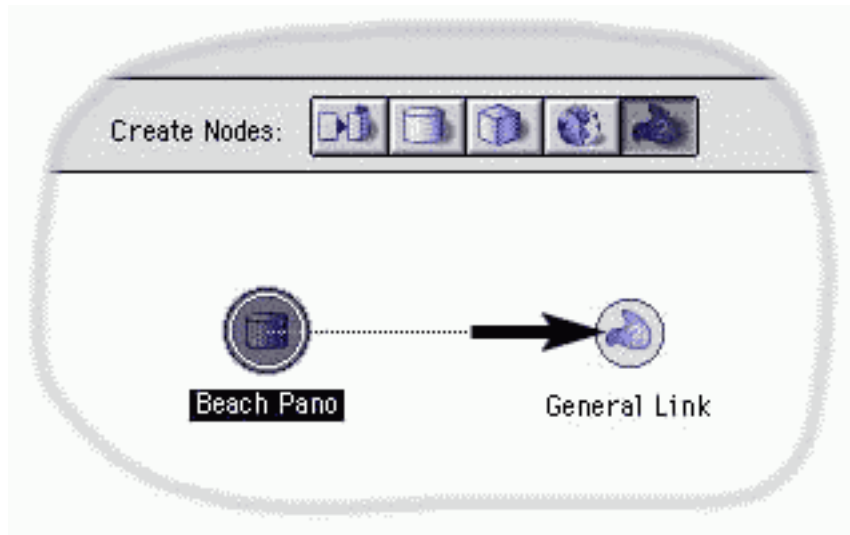


Blob link node



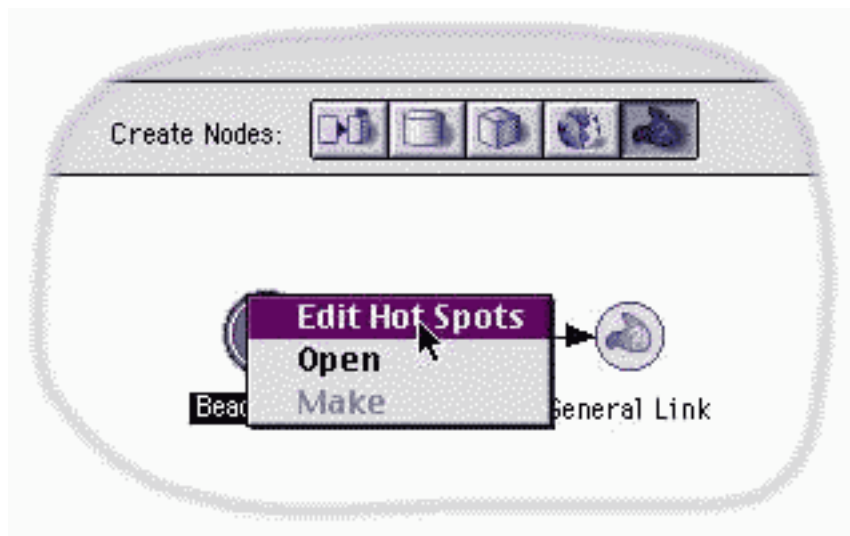
If creating a panorama with hot spots for use on the web, you can also use the URL node in the Scene Maker tool. However, this is not normally recommended, as the URL target of the hot spot becomes a part of the file's data track. This implies that if the web page needs to change, the panorama itself must be edited rather than simply updating the web page's HTML.

Once the blob node is created, you'll set a link between the nodes using the single link arrow.



Link to the blob

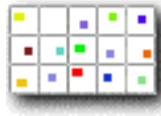
Once the link is created, clicking and holding on the panorama icon brings up the hot spot editor, which then allows you to create the hot spots on the panorama. Once the hot spots are defined, you build the scene (i.e., the single panorama though now with a hot spot).



Accessing the Hot Spot Editor

Once created, the panorama with a hot spot can then be embedded on a web page or used in a multimedia title.

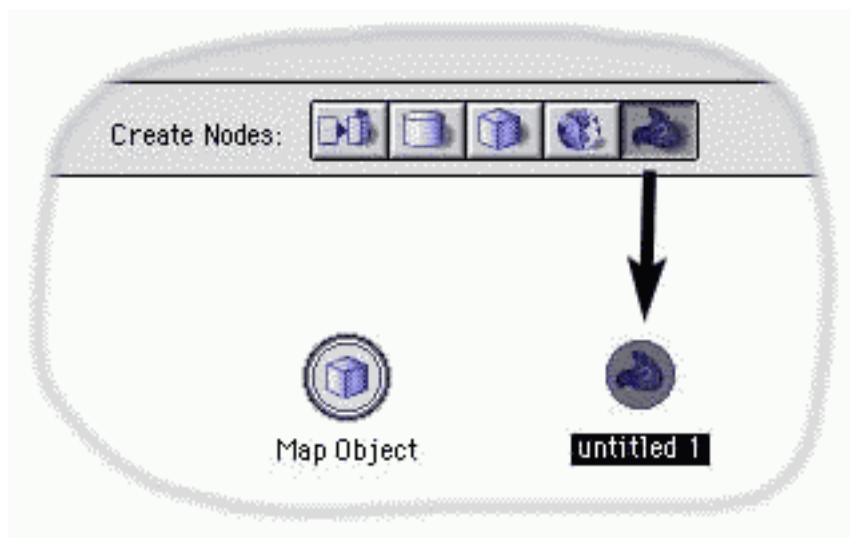
QTVR Scenes – Hot Spots on Objects



Like panoramas, single objects with hot spots are normally only used on a web page to provide links to other web sites, or to other QTVR media on separate web pages. Another use for single objects with hot spots (as with single panoramas) is within a multimedia authoring environment where the hot spots can be used to initiate actions such as play sounds, show a movie, or reveal hidden text.

Thus, creating hot spots on an object also does not involve a specific target panorama or object, but rather just an undefined hot spot area that provides the cursor change. Instead of defining the link within the object, the fact that a user clicks on the hot spot is interpreted by either the multimedia authoring tool or the browser plug-in to execute the link action.

To create hot spots in a QTVR object, you'll use the QTVR Authoring Studio's Scene Maker tool. As with a panorama, you'll use a special node called a "Blob" node to provide an undefined destination for the link.

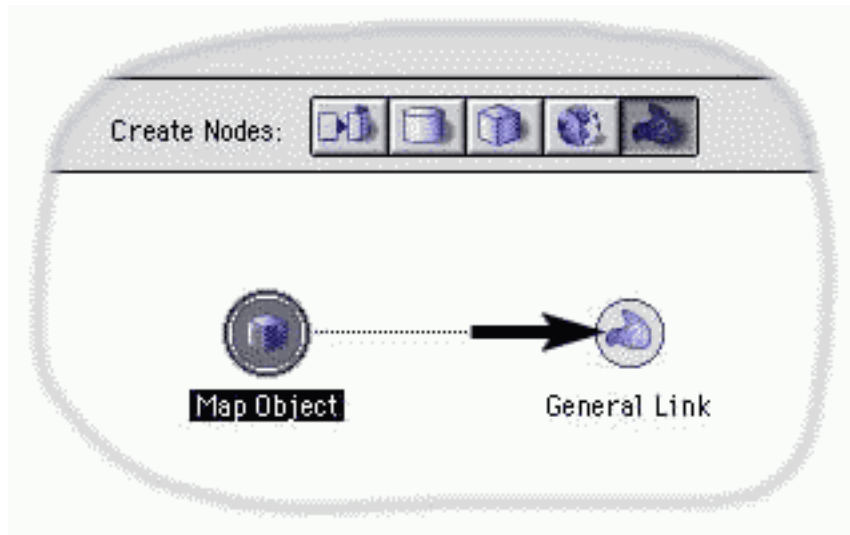


Blob link node



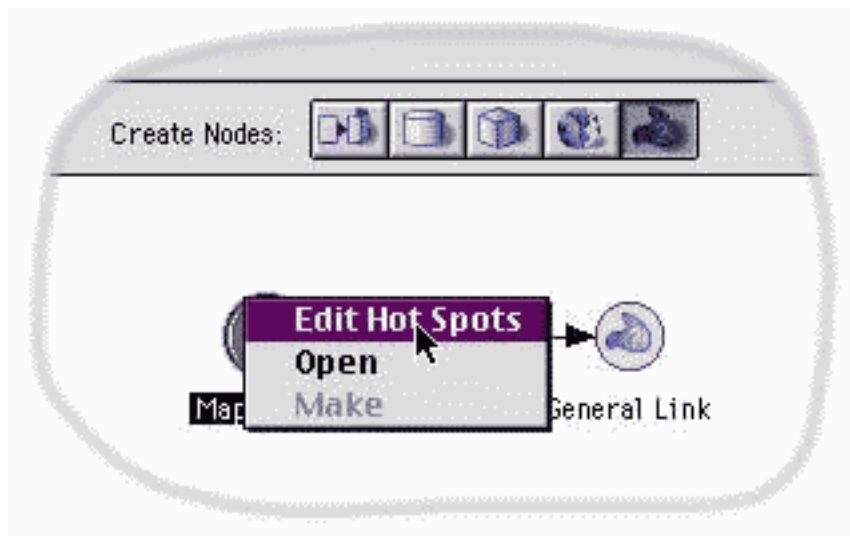
As with panoramas, when you are creating an object with hot spots for use on the web you can also use the URL node in the Scene Maker tool. However, this is not normally recommended, as the URL target of the hot spot becomes a part of the file's data track. This implies that if the web page needs to change, the panorama itself must be edited rather than simply updating the web page's HTML.

Once the blob node is created, you'll set a link between the nodes using the single link arrow.



Link to the blob

Once the link is created, clicking and holding on the object icon brings up the hot spot editor, which then allows you to create the hot spots on the object. Once the hot spots are defined, you build the scene (i.e., the single object though now with a hot spot).



Accessing the Hot Spot Editor

Once created, the object with a hot spot can then be embedded on a web page or used in a multimedia title.

QTVR Scenes – Development Process



Successful and efficient development of QTVR scenes requires even more discipline than creating individual QTVR panoramas or objects, as it encompasses several additional processing tasks. Without a good understanding of the overall development process for scenes, the additional complexity presented by these extra tasks can result in significant re-work, considerable extra expense, or even lost opportunities when it comes time to deliver the final product. At its most basic level, the development process for scenes can be divided into four stages:



During planning, the user experience is determined, story boards are produced, panorama and object specifications are created, and a production timeline and budget are prepared.

Planning for QTVR scenes, like panoramas and objects, should address three key points:

- Determine the user experience
- Create detailed production specifications
- Create a development plan and budget

1) Determine The User Experience

In the case of QTVR scenes, the main aspects that will effect a user's experience are:

- the number and types (i.e., full or partial) of panoramas that the scene will contain. To create a realistic "walking through the scene" experience, panoramas should be created 6-10 feet apart. As the distance between panoramas increases, the effect will increasingly seem like a user is leaping from node to node rather than walking through the scene.
- the number and types of object movies the scene will contain. Which objects will be animated or scalable, and how many views of each object will they contain?
- which panoramas and objects will be linked, enabling users to access the respective files via a simple mouse click in the final scene.

Determining the answers to these questions will allow you to create detailed specifications for the components of the scene, as well as specify the scene creation tasks required.

2) Creating Detailed Production Specifications

Once you have determined how you want users to interact with your scene, you can create detailed specifications for the panoramas, objects, and the scene itself. Your specifications should address the following:

- an overall location or site plan
- number of panoramas and objects as well as their locations on the site plan
- all of the detailed specifications for the individual panoramas and objects which comprise the scene (refer to Chapters 4 and 5 for these specifications).
- the various links between panoramas and objects in the scene, along with an indication of the hot spot color IDs reserved for each link
- the view (object) or orientation (panorama) that will be shown when a user clicks on a given hot spot

3) Create a Development Plan and Budget

Your development plan needs to address four facets: the people, equipment, time, and budget needed to complete your project.

PEOPLE - Developing QTVR scenes requires a broad range of skills. The chief skills include:

- Multimedia development experience
- Still photography, videography, or 3D scene rendering experience
- Graphics editing experience
- Experience with using MPW (Macintosh Programmer's Workbench) tools and scripts

EQUIPMENT - The requirements here vary considerably depending on the capture approach used. Typical equipment for photography or video image capture includes either off-the-shelf photographic components or products sold by QTVR rig companies. A listing of QTVR rig companies and off-the-shelf products is provided in the course appendix.

You will also need a well equipped computer to efficiently create QTVR scenes. Although you can use nearly any Macintosh with sufficient hard disk space and RAM memory, it is recommended that you use the following when creating scenes:

- Power Macintosh (any model, though faster CPUs will reduce processing time)
- CD-ROM drive
- 40 MB RAM (more is always better)
- Mac OS System 7.1 or higher

TIME - The time required to produce a scene is more dependent on how long it takes to capture images and create the individual panoramas and objects rather than the specific scene creation tasks. However, if your scene has an extensive number of links, the additional tasks involved in scene creation can equal or even exceed the time required to create the individual QTVR panoramas and objects. Specifically, you will need to plan on enough time to create the various hot spots, to merge hot spots into the panoramas or objects, to enter all link specifications, and to test the resulting scene created to ensure that all links work as planned.

Thus, your timeline should consider the number of panoramas and objects you'll create as well as an estimate for some image editing, hot spot creation, and final testing of all links in the scene. A general estimate for complete development of a QTVR scene on a per node (i.e.,

panorama or object) basis could range from 1/2-4 person/days per panorama from start to finish. This would account in most cases for planning, site preparation, capturing images, digitizing, and creating the final QTVR scene.

BUDGET - It is difficult to draw any generalizations on a cost per scene basis since so much depends on the nature of the scene itself. For example, a scene with many nodes (panoramas and objects) but only one or two links per node is much easier to create than a scene where each node has many links to other nodes. In addition to the cost of creating the individual panoramas and objects, there is also the additional time expense of creating hot spot files and then merging them into their respective QTVR panorama or object files.

Clearly creating a hot spot movie for an object with a 1 x 36 composition of frames is much quicker and easier than creating a hot spot movie for an animated object that contains 14 x 36 row/column frames and 10 animated frames for each of those positions. Once you have an understanding of the people and skills required (as well as their hourly rates), the amount of time necessary to produce the required components and the equipment that will be purchased or rented, you will be able to estimate how much it will cost to complete your project.



During the capture stage, source images for the panoramas and objects are captured or created. The tasks here will depend on whether you use photographic, videographic, or computer-generated image technologies. Refer to the section on QTVR Panoramas or QTVR Objects for details of this step.

There are no special additional aspects of capturing images for scenes besides those already covered in the other two sections of the course.

However, note that normally when capturing images for a number of individual panoramas in the same general area, you should not alter the lighting from node to node. If you do, the shadows cast in the respective panoramas will change and may create a disconcerting experience as users move around in your scene.



When creating the individual nodes for the scene, the source images are digitized and processed into a single QTVR panorama or object. Refer to the sections on QTVR Panoramas or QTVR Objects for the respective details of this step.

You can create the individual nodes directly from within the Scene Maker tool in the QTVR Authoring Studio. Before links and hot spots can be defined, though, the individual nodes must be completed.



One key point to note, however, is that you should specify identical window sizes for the panoramas and objects that will be in the scene. Otherwise, the size of the eventual scene file's window will be the largest of all nodes in the project - and any nodes which have a smaller window size will appear in the upper left corner of the scene window with white space padding the empty area.



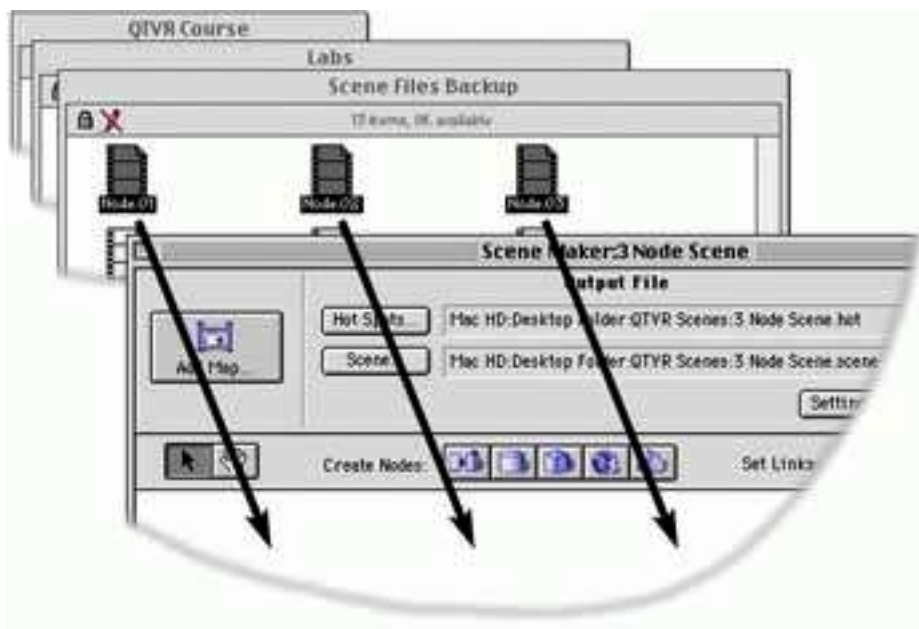
In this final stage, the scene layout is created, links are specified, along with target link orientations or views. The scene is then created.

Once all QTVR panoramas and objects are created, the final scene creation steps can be executed. There are essentially three main steps for creating QTVR scenes which reflect the various tasks of the process:

- Create the scene layout and identify the links between nodes
- Create the hot spots for each node and define the target of each hot spot link
- Adjust scene settings and create the scene

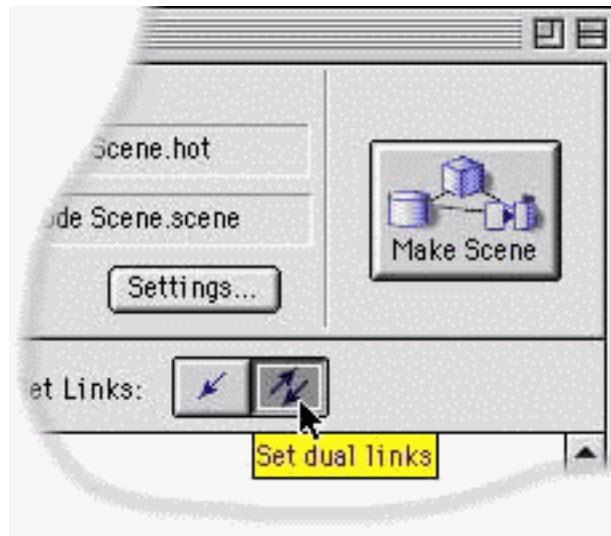
Create the Scene Layout

The layout of all nodes in the scenes is created most easily by simply dragging the individual nodes that have been created right onto a Scene Maker window.



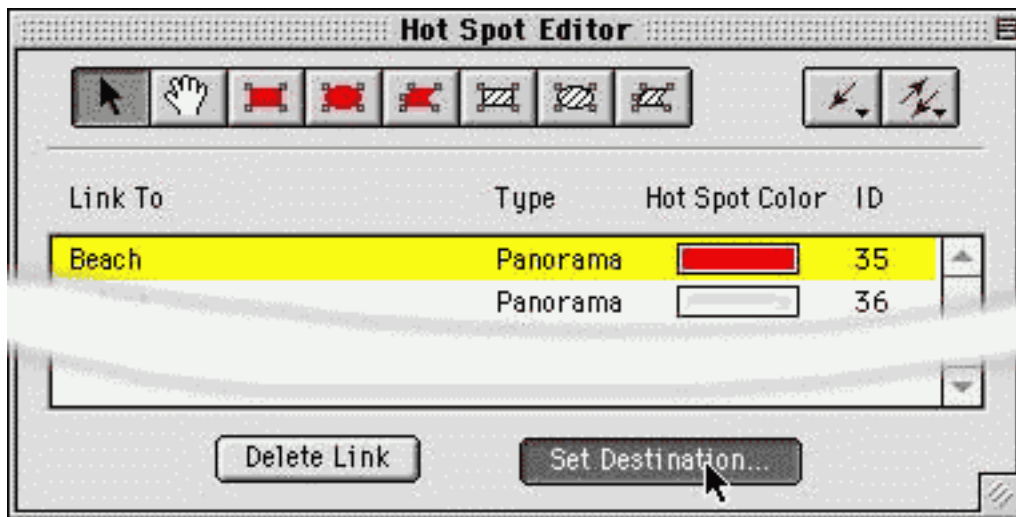
Alternatively, you can specify individual Panorama Stitcher, Panorama Maker, or Object Maker projects and build each in turn directly on the layout window.

Once the nodes are laid out, you connect those nodes that will be linked with the link arrow tool. Be sure to create two-way links if you intend to let your users move in both directions between nodes in the scene.



Create the Hot Spots and Specify Link Destinations

With the scene layout completed, click and hold on each node in turn to bring up the Hot Spot Editor. Create each link in turn, and set the destination view of the link's target node.



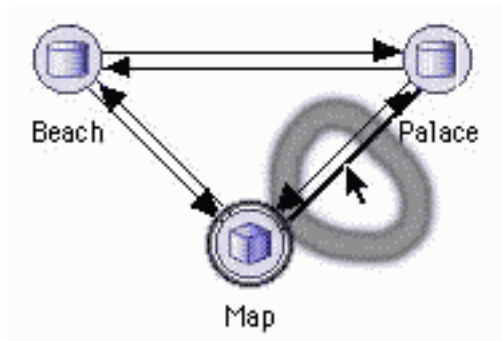
Set Scene Settings and Link Info

The settings for the scene are similar to those for individual panoramas and objects, with many fewer options since these settings merely apply to the scene as a whole. Thus, you will only be able to set such items as the scene's window size and copyright information.

However, prior to building the scene this is also a good time to enter link text if you prefer. Link text appears in the QTVR controller bar when a cursor floats over the associated hot spot, as shown in the graphic below:



To set the text for a link, you double-click the link itself on the scene's layout window:



When all settings and links are complete, you create the scene. Be sure to test out all links for the size and location of the link hot spot, the proper view of the target node, and appropriate link text. If any thing needs to be changed, return to the Scene Maker project and correct the mistake, then rebuild the scene.

You've reached the end of the course!

Thanks for taking the time to immerse yourself in QuickTime VR. If you studied any or all of these materials, we'd appreciate your feedback. Please send any comments to:

info@letmedoit.com.

Also, note that we also provide a more in-depth, self-paced course on Apple's QuickTime VR Authoring Studio tool. The course features a 274 page workbook and CD-ROM complete with source images and material for the extensive labs, which cover all aspects of creating panoramas, objects, and scenes using the tool.

For more information on the self-paced course, and to download a sample, visit our website at:

www.letmedoit.com/qtvr/sp/index.html

Thanks again, and best of luck with your virtual work!



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