

TECHNOTE: Getting Up to Speed with QuickTime VR: Notes from the Field

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Like many developers, I'm new to QuickTime VR. I started working with VR back in November, 1995, and over a period of three intensive months, immersed myself fully in this new Apple technology. Most of my learning was through trial and error, investigating a whole range of common problems encountered by Apple developers. This Technote is an attempt to share some of the highlights of my experience.

QTVR creates QuickTime movies that are interactive and navigable. There are two basic kinds of movies: object and panorama. With object movies, users can turn an object to see it from different angles. With panorama movies, users can spin around and see a scene from different angles. Panoramas can be linked with hot spots, so that a user can jump from one node to the next or open object movies.

This Technote is intended for multimedia producers who want to use QTVR to produce either object or panorama movies for the World Wide Web and CD-ROM titles.

Assessing Your Needs: Equipment & Tools

What equipment and tools do I need to build QTVR movies? That's the first thing everyone new to QTVR wants to know. There are a lot of options, of course, depending on your budget and objectives. If your objective is to build a QTVR movie that you can quickly post on the Web — for example, it has to be completed in a few hours — your best choice may be to use a digital rather than a film camera. On the other hand, if you want to build a professional CD-ROM title with sharp, high-resolution images, you'll need a film camera with an ultra wide-angle lens and a means of digitizing the images you've shot.

Before addressing your equipment needs, however, you may want to consider the following:

- Time — i.e., production or turnaround time to complete the project
- Quality — i.e., image resolution, color, and sharpness
- Integration — i.e., the number of nodes and the complexity of object hotspots, as well as special transition effects.
- Deliverables — i.e., for the Internet, CD-ROM, or for a kiosk. In addition, for which platform, i.e., Macintosh and/or Windows?

It's important, in any case, to assess the needs of your QTVR project before plunging into it.

The QTVR Authoring Kit is essential if you want to make or link panorama and object movies. If the panorama or object movies already exist, you can use, for example, Apple Media Tool 2.0 to integrate them with other content. There are other tools you'll need to produce QTVR movies as well, which I'll talk about later.

Using a PowerPC as Your Computer of Choice

Your main expense for QTVR development is a computer system. A PowerPC is the recommended computer of choice. The faster the processor, the faster you'll be able to "stitch" images together. (Stitch is the name of the MPW tool that takes multiple images and algorithmically combines them into one complete panoramic image.)

For a standard configuration, 40MB of RAM is recommended. More or less RAM may or may not be necessary, depending on the size of the movies you're building. You can also use Virtual Memory or RAM Doubler when you don't have enough RAM, but expect performance to slow down by as much as 10 times. I suggest

calculating how much RAM you need for your general needs and then buying it. See Technote 1030, "A Technique for Estimating the Total RAM You Need for a QuickTime VR Project," for details on how to determine your RAM requirements.

The most common problems stem from situations where there isn't enough RAM. In my opinion, sufficient RAM is more important than a faster CPU because it saves you time.

Camera Features for Best Results

The next major expense is your camera equipment. The recommended camera is an 35 mm single lens reflex (SLR) with a 15mm lens. Apple's Developer University QTVR class uses a Nikon f90 with a Nikon 15mm lens. This camera setup is highend. A much less expensive camera, under \$1000, can give you comparable results because, typically, you won't be using the highest resolution PhotoCD images.

The next section details some of the camera features you may want to consider in selecting your equipment.

Using an Ultra Wide-angle Rectilinear Lens

A good camera for QTVR development ought to have an ultra wide-angle rectilinear lens (i.e., 14-20mm).

This is important so you can get a large vertical field of view (vFOV). A large vertical field of view means that your camera lens will capture more data vertically, which, ultimately, lets your QTVR users pan up and down.

I don't want you to get the wrong impression, however. You don't necessarily have to use an ultra wide-angle lens to create QTVR movies. A 28mm lens, for example, may be adequate if you're only going to shoot outdoor panoramas where the subject is often confined to a shorter vertical field of view.

Shooting in Portrait Format

Normally, you shoot in portrait format in order to maximize your vertical FOV. The horizontal FOV is not significant: as long as the images overlap, the stitcher will connect them together. Shooting in landscape format trades vFOV for less images (possibly saving you on the cost of film processing and digitizing). You can always imitate a longer lens by cropping the top and bottom of the higher resolution images, but you can't imitate a wider lens.

This is the main reason expensive panorama cameras that rotate aren't a good complement for this technology. They have excellent horizontal FOV, but poor vertical FOV. The disposable panorama cameras have the opposite problem: a 28mm lens (good), but they crop 1/4 from each side of a normal-sized negative. As a result, a 15-exposure camera barely makes a single 360° rotation with minimal overlap when shooting in portrait format.

Using a Sigma 18-35 mm EOS Zoom Lens

Without getting into specific product endorsements, I ought to say what camera I have been working with. I bought a Sigma 18-35mm auto focus lens (which costs about \$500) to use for both QTVR and regular photography. At 18mm, its vFOV is 90° when in portrait format. Surprisingly, except for fisheye lenses, I haven't heard of an after-market modern lens that was too low-quality for QTVR. Let me explain before photographers go looking for a rope to lynch me.

QTVR blends images together as it stitches them: the horizontal edges, for example, blend together. As long as you have generous overlap (at least 50%), you may not see problems on those edges. You may still have some distortion on the edges, but this is generally floor or ceiling. (Worst case, you can just crop it out.)

To hedge my bets, I admit that you get what you pay for, and the more expensive lenses do have higher image quality. It's important to decide how much you need to spend. If you are planning on using the higher-resolution images, it makes sense to invest more of your budget in the lens.

One important point to bear in mind about using zoom lenses: keep the same focal length for all your shots and be careful not to bump the zoom.

Using a Standard 15mm Lens

The main advantage of using a 15mm lens is that all the QTVR examples and scripts are configured for that particular lens. What this means is that you can simply substitute your images to get immediate results. Otherwise, you have to learn how to modify the parameters for your specific lens and its configuration. Consequently, you can introduce errors that effect the final quality of your production, or at least cause you a lot of headaches.

Adding a Tripod with a Panorama Head

While it is technically possible to shoot a panorama handheld, the results are never as good as with a tripod. The tripod is used to level and square the camera and hold it steady as it pans in even increments around the nodal point of the lens.

For my projects, I use a standard, heavy duty video tripod and a Kaidan Universal Pan head with levels. It has an advantage because you can adjust the center of rotation to the nodal point of any wide-angle lens. The nodal point is the point where the lens focuses the entire image through a single point. This setup is necessary to avoid parallax error. (See the QuickTime VR Authoring Tools Suite, Volume 1, pp. 6-9, for more details).

Also, the Kaidan Universal Pan head has click stops. This means that depending on which lens you have, you can set up the click stops to lock into place at each point necessary to achieve that 50% overlap as you shoot the panorama. Another Universal Pan head that has click stops as well is made by Peace River Studios. Both have great attributes. To get information on both, you

can find them on Apple's QTVR website at
<http://qtvr.quicktime.apple.com/Develop.htm>

Other designs are always upcoming, so continue to check out the website for information. Just be sure the pan heads have the above features.

Note that for the professional photographer, Peace River Studios provides a highend, durable 360° rig that you might want to check out.

Using a Camera with Auto Film Advance

If you have to manually advance the film for each exposure, it's more than likely you'll misalign the camera on the tripod and compromise the entire panorama. Consider this a necessity for achieving professional results.

Having a Remote Shutter Release

Again, the more you touch the camera, the greater the chances of having the images not overlap consistently. I have both an infrared remote and a manual remote. I don't trust the infrared remote to always trigger the shutter. And if it's hard to hear, it's easy to skip a critical photo.

The Advantage of Manual Exposure

It's best to have even lighting so you can use one exposure setting for all your shots. Typically, you'll have bright spots (for example, the sun, bright windows, and so on) that will affect an automatic exposure. If you have lots of overlap (more than 50%), the QTVR stitcher can blend the images together, even if one is dark and the next is light. Exposures may become more of an issue when there is less overlap (less than 50%).

In my work, I've tried both manual and auto exposures. Depending on the lighting conditions, you want to have both options available to you. A good incident light meter is recommended to get an accurate ambient light reading.

Note: for automatic metering, matrix metering — which is a method for how scenes are averaged — may result in better exposures.

One little tidbit to know is you can adjust your exposure gradually up or down in the same panorama. This is contrary to most thinking, which assumes that keeping the exposure absolutely constant is critical for best results.

Using Manual Focus

Interesting scenes depend on having objects both up close and far away. You want to control the focus and aperture to get the optimum depth of field. I always turn off auto focus once I have set the proper focus.

I have a new Canon Elan IIe and find that I disable most of the coolest features because I want to control the focus and exposure when I shoot panoramas. The autowinder, manual settings and remote control are the features that make it completely adequate. What I've discovered is that all you really need is a camera with the basic features I've talked about. You may not need the latest

model camera to get good results. If I had an ultra wide-angle lens for my 18 year old Canon A1 with motor drive, it would probably work just as well.

Lighting

Lighting is another area that makes a tremendous difference in the quality of your panoramas. I've learned that scenes unevenly lit and shot with a fixed exposure don't digitize very well. You lose detail in the shadows and bright spots, although this may be an exposure rather than a lighting problem. Low contrast scenes are an even worse problem. In any case, my favorite results were achieved outdoors with indirect lighting.

One thing to keep in mind: you can't use conventional techniques where your lights are stationary and typically positioned behind the camera because as the camera pans, the lights may show up in the final panorama. You may need to hide your lights for best results. It goes without saying that you ought to consider appropriate lighting equipment for your QuickTime VR project.

A Technique for Shooting Outdoor Scenes Where You Have Less Control Over Lighting

If you're shooting outdoor scenes with direct sunlight and contrasting shadows, where you have little control over lighting, you may want to try the following technique:

Using a camera with manual exposure control and a good light meter, shoot multiple bracketed exposures at each position that range from the average for the whole scene to optimum for that individual exposure. Mix and match the shots to stitch -blend the optimum panorama. You can use the -files option to specify nonsequential image filenames.

It's important to have lots of overlap (50%+) in order to get even blending. (See what happens by removing every other frame and blending with only minimal overlap. Another experiment — turn off -blend and compare!)

You may want to keep the shadows a little underexposed and the brights overexposed. You may also want to use Photoshop to readjust the levels after everything is stitched together.

The objective of this technique is to compress the dynamic range of what our eyes perceive, so that it can be optimally recorded onto film and then displayed on a computer monitor and still look realistic.

Digitizing Images

If you use a film camera, you'll need to digitize the images. I happen to like film because it lets you capture high-quality images and store them while in the field. Later, with proper scanning equipment you digitize those images and store them on your hard disk. PhotoCDs are especially good because they have excellent quality and storage is inexpensive. Plan on at least \$1.00 to \$1.50 per image from Kodak, and waiting at least four days to as long as a week for processing. There are Labs that will match that price with much faster

turnaround. (The lesson: shop around). \$2 per image is the high end of PhotoCD processing.

I don't recommend using medium format (120 or 220 film) or large format (4" x 5" or larger) film cameras because digitizing the larger negatives is 5-10 times as expensive, and there may not be any quality advantages to medium or large format for QTVR movies.

Alternatives to PhotoCD

The alternatives to PhotoCD are film, flatbed or drum scanners. These vary greatly in cost, quality and convenience. Remember, you need to store the data. I like scanning the original negative: this saves the cost and time necessary for prints. The cheapest alternative I've seen is Storm's EasyPhoto Reader, which costs less than \$300. But I've noticed that the photos seem to slip when scanning and may stitch imperfectly. Others have been pleased with the results produced by flatbed scanners.

I recommend using lossless compression on the original scans to maintain quality during production. The final QTVR movie, of course, will be compressed. There are new removable storage devices that rival the cost of PhotoCD.

Using QuickTake and Other Digital Cameras

I've used the QuickTake digital camera — with mixed results. I can't recommend it for shooting panoramas with a lot of detail, but it does give acceptable results for small panoramas that are useful for the World Wide Web. The main limitation is that the original images are compressed, and this causes a definite loss of image quality. Digital cameras also have storage limitations, so consider this when you're shooting panoramas that require 16+ images per node. You can carry along a PowerBook and download each image as it's taken; however, this extra equipment might not be in your budget and on some locations not always practical. Think of battery life.

Perhaps the ideal use for the QuickTake or other digital cameras is in scouting locations and in rapid QTVR prototyping and production.

For the QuickTake, Kaidan makes a wide lens that doubles the horizontal and vertical FOV. Surprisingly, however, this also makes your panoramas smaller because you have more overlap.

The professional digital camera backs (e.g., Kodak) that attach to 35mm cameras have a CCD much smaller than 35mm film, so the effective field of view is decreased. Different models have different sized CCDs. But even in the best case, expect to lose 20-50% of your field of view.

Using Video Cameras

Video cameras (such as Hi-8 and S-VHS) have better image quality because they don't suffer from compression. There is no field storage problem because you're storing the images on video, but vFOV is a limitation. Most video cameras don't have wide angle lenses (typically, comparable to a 50mm lens on a SLR camera). Although the wide-angle adaptors tend to slightly degrade the

image, I would still recommend them to capture a greater vFOV.

Don't expect, however, video cameras that accept an SLR lens to solve the problem such as a Canon L2: they generally only capture a small portion of the normal image and effectively multiply the focal length by a factor of 5, so that a 15mm SLR lens behaves like a 75mm lens. As a consequence, wide-angle lenses become in effect telephoto lenses.

Object Movie Production

Video cameras attached to an AV Macintosh are ideal for shooting object movies because they're cheap (no film processing cost), fast (they're immediate), and easy to adjust (zoom lens and manual focus/exposure). But you also need a rig to hold the object as it rotates, and optionally, allow the camera to swing up and down, as it stays focused on the center of the object. The most commonly made mistake is having the object shot in uneven increments, and not having the object properly centered in the frame.

The Necessary Set of Software Tools

Software tools are the next area that require significant investment. If you don't already own MPW Pro, I'd recommend you get it with the QTVR bundle. MPW Pro is the programming environment used for the QTVR tools. You will want to write scripts to automate for your setup and MPW Pro includes utilities that will make your job easier. The MPW Pro bundle gives you a complete set of MPW extensions and documentation to do everything necessary for QTVR.

Using an Image Editing Tool

Adobe Photoshop is a popular tool for touching up QTVR panoramas. At a minimum, plan on having PhotoFlash or another, less expensive photo editing application in your software library. You'll need it to crop, rotate and do simple edits, as well as resize and touchup your scenes. If you're going to add object hotspots to your scenes, you need a more powerful image processing software package.

Object movies need a QuickTime movie editing package. Adobe Premiere or Strata Media Paint or a similar application is useful for capturing and editing sequences that become object movies.

It's also possible to create 3D-rendered panoramas and object movies, using one or a combination of software packages, such as Infini-D, Stratavision, or KPT Bryce. (For samples of some KPT Bryce, check out Apple's website at <http://qtv.quicktime.apple.com/Radu.htm>.) These can generate snapshots that can be stitched together, or snapshots of rotating models that can be converted into QTVR object movies.

Using Authoring Tools

HyperCard is used for the scene editor to link hotspots and is handy if you want to edit any HyperScripts or add your own enhancements.

If you are going to integrate QTVR movies with other media and create a title, you'll definitely need an authoring package. Macromedia Director and HyperCard are the original tools for this. Director is more popular for QTVR because it is cross platform, but HyperCard is a little simpler to program.

Apple Media Tool 2.0 also fully supports QTVR movies and doesn't require any programming expertise, and is cross-platform as well.

Apple Media Tool 2.0 is especially cool for non-programmers because you don't have to do any scripting for zooming or panning your scenes. The tool lets you point and click to set the desired attributes.

The QTVR Learning Curve: One Perspective

Having worked with QTVR over a period of three months, I found the learning curve to be steep. There was a great deal to learn at the beginning. In time, as I gained experience, I could work through problems more rapidly.

In the area of photography, I consider myself to be just good enough to realize all the subtle mistakes I make. After spending 50 hours and shooting 80 panoramas with 10 different camera rigs over a three-month period, I feel pretty comfortable. Lighting is still the biggest challenge for me. I've also spent about 25 hours trying to master how to use a PhotoCD scanner, but am still learning.

My objective was to understand QTVR as completely as possible. Don't get the wrong impression that this is what it takes for everybody to get good QTVR results. Depending on your own objectives, the time that it takes to get up to speed may vary.

Three Phases to Master

There are three phases to master in building QTVR movies:

1. *Shooting the scenes.* If you aren't a professional photographer, the reality is that you may end up with average results. Photography is, after all, an art form. You may not even care until you want to make a commercial product and the market demands professional quality. So this can be the most or least difficult area to master.
2. *Using the MPW tools.* MPW has a UNIX-like command line interface, which may be unfriendly to a non-programmer. The documentation that comes with QTVR assumes that you have at least some familiarity with MPW. You'll benefit by learning more about MPW in order to understand how to use the environment. Fortunately, the QTVR Authoring Suite comes with a complete collection of scripts and sample images that are easy to get started with. (A future Technote will address MPW issues in working with QTVR.)

3. *Learning HyperCard/MacroMedia Director scripting.* If all you want are simple linked node multi-scene panoramas, the QTVR Player will do it all, and this will not be a concern for you. But if you want to link object movies and make things intelligent (i.e., have code that controls the movies), you need to use an environment that supports XCMDs or XObjects. Currently, Director is the most popular cross-platform authoring tool. Apple Media Tool 2.0 is the latest QTVR-compatible authoring tool that greatly simplifies content integration and linking of nodes.

Taking the Developer University Class

Apple's Developer University offers developers a three-day class in QTVR essentials at a cost of \$900. In preparation for the Developer University class, I spent about 10 hours playing with the Company Store tutorial that comes with QTVR. In the class, we practiced all three phases of mastering QTVR: shooting scenes, working with MPW, and scripting with Director.

During the three-day class, I shot my first 3 panoramas, stitched them together, and built a multi-node scene with an object movie. I also figured out how to write a script for the QuickTake camera and work around most of the common problems I'd encountered, such as bad script parameters and configuration issues. Taking the class gave me the confidence to venture out on my own and try new things.

Summary

Over the last several months, I've spent over 50 hours writing scripts and actively using the tools to create a variety of 80 panoramas and multi-node scenes. I feel pretty comfortable with the tools, but still I'm learning new things everyday. My experience with QTVR is probably typical for most multimedia producers.

The important thing is to recognize your own limitations and get help where necessary. I don't think it's practical for someone to approach this technology without being an expert in at least one area, such as photography or MPW, and at least familiar with another, such as Director or Apple Media Tool. To be a master of all three areas is the challenge of learning QTVR.

Further Reference

- *QTVR Authoring Tool Suite*
- *MPW Reference Manual*
- *Technote 1030, "A Technique for Estimating the Total RAM You Need for a QuickTime VR Project"*

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