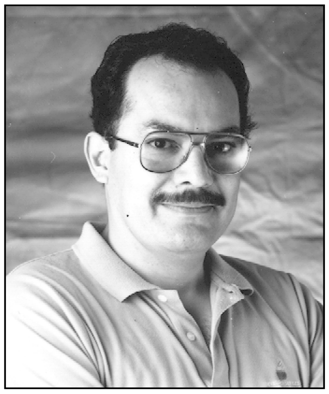
QUICKTIME 1.0: "YOU OUGHTA BE IN PICTURES"

QuickTime is Apple's new architecture for enabling the Macintosh to handle time-based data. The recently introduced QuickTime 1.0 makes it easy for you to add dynamic media like video and sound into your applications—and that's just the beginning. Two sample programs show you how to do the two most basic (and important) QuickTime tasks: playing existing movies and creating new ones.



GUILLERMO A. ORTIZ

The world isn't standing still—it's moving, *fast*—and Apple intends to stay at the front of the race. When Apple came out with the Lisa® and then the Macintosh, the idea of a document file that mimicked a piece of paper was a big deal. But now it's not. Users have taken the "paper" metaphor for granted and are now looking for new metaphors that increase their ability to communicate. One way to do that is to allow documents and applications to contain and display data that *changes*.

QuickTime™ is more than just the ability to record and play back movies—it's a fundamental addition to the Macintosh Operating System. Just as QuickDraw™ gave the original Macintosh the edge of sophisticated graphics in 1984, QuickTime will give the Macintosh another edge over other computers: the *built-in* ability to handle data that changes with time.

Until now, the Macintosh Toolbox has not provided a standard way of dealing with dynamic media, and some developers have come up with their own solutions, especially in the areas of video and sound. Unfortunately, this has resulted in confusion and a lack of standards and basic system support for these data types. Apple has created QuickTime to provide a standard way of dealing with data that changes with time. Even more important, QuickTime gives you the necessary support software so that you can spend your time *using* new data types instead of designing, implementing, and maintaining them.

QuickTime 1.0 works on all color-capable Macintosh computers running Color QuickDraw (models with either a 68020 or 68030 processor) and either System 6.0.7 or System 7.0; a later version will add QuickTime support for monochrome, 68000-

GUILLERMO ORTIZ Instead of giving you details about his life, Guillermo would like to share with you a passage from a soon to be published book. Some say that his affinity for this book tells you much more about Guillermo than we ever could.

Tired, hungry, and thirsty after a long and arduous trek, DunKennsan, also known after his conversion as "He who seeks the Light," entered Brucewhandra's cave, and, without waiting for the religious man to acknowledge his presence, he posed the question burning in his mind: "Why 'QuickTime'?" As a response, Brucewhandra, the man called the Wisest, kept repeating the mantra now famous among the true followers: "Calls that take a Movie can take a Track or a Media. Calls that take a Track can take a Media. Calls that based Macintoshes. As a result, you, the developer, can take it for granted that QuickTime will be available on *any* Macintosh running your software.

QuickTime 1.0 makes it possible for your program to manipulate the audio/video sequences we call *movies*. (The size, duration, and quality of the average movie largely depends on how much disk space you have for movie files.) It also includes routines for the compression and decompression of still and dynamic images (which should encourage you to use color images without worrying about how much space they take up).

The result of all this is something that you'll like very much: applications and documents that give users a richer experience with your product than they can get with non-QuickTime Macintosh applications or applications on other platforms. QuickTime will make possible a new generation of Macintosh software and hardware solutions that until now have been available only using expensive and narrow-purpose hardware.

ENOUGH MARKETING STUFF! NOW THE DETAILS . . .

QuickTime 1.0 contains the following parts:

- *Movie Toolbox*. This contains the calls needed for playing and recording dynamic media. It communicates with the necessary components for the type of media being used.
- *Component Manager*. Previously called the Thing Manager in internal circles, this piece of QuickTime provides a high-level interface that allows applications to communicate during run time with a collection of software objects. These components, affectionately called Things, provide a variety of functions. At present, these functions include image compressing and decompressing, movie data handling, video digitizing, and playback controlling.
- *Image Compression Manager*. This tool handles the interaction among the components that compress and decompress image data. Its services are available both for movie making and playing and for the compression and decompression of still images.

MOVIE TOOLBOX

The basic component of QuickTime is the *movie*. At its highest level, a movie contains one or more *tracks*, each of which points to data of one type (see Figure 1). A movie also includes its time scale, duration, size, location and poster information, current selection and insertion point (if any), preferred volume, image scaling and positioning matrix, and other information (more on this later).

take a Media can take a Track." After sixty-one nights and sixty days DunKennsan left.

From *DunKennsan, the Favorite Disciple*, by Lord James Batson. Any resemblance to any real person or event is intentional and should be construed as such.•

In the future, QuickTime will be able to do things like control audio-visual equipment and manipulate custom-defined types of data (such as scientific instrument data). Also remember that QuickTime will become even more powerful when compression and decompression hardware becomes cheaper and is found in most users' computers.•

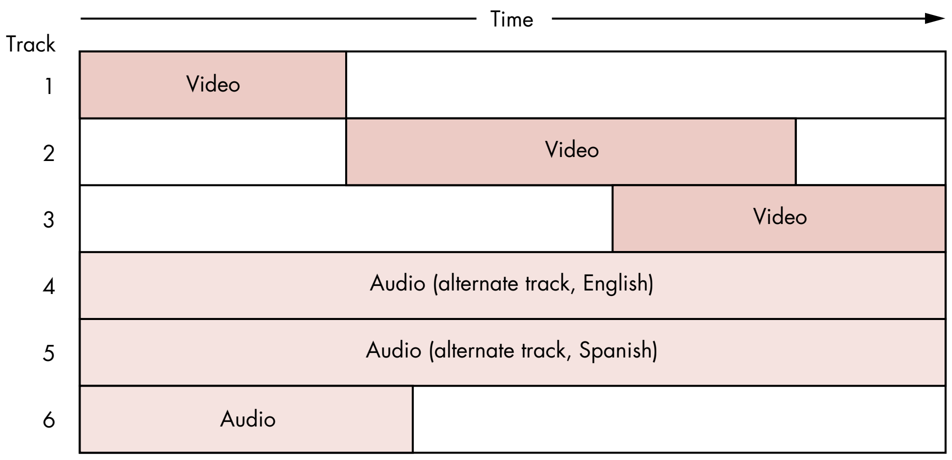

Time
Track
1
Video
2
Video
3
Video
4
Audio (alternate track, English)
5
Audio (alternate track, Spanish)
6
Audio

Figure 1
A Movie and Its Tracks

A movie contains any number of tracks (it's true that a movie can have zero tracks, but that's kind of a boring case). Each track has a *media* associated with it, which points to the "raw" data that the track draws from when it plays. Other track parameters include time scale, duration, time offset within the movie, audio volume, and track type. The *track edit list* is the list of media subsegments that define the track's output.

Each media references a file that contains its raw data; the file can be any place you can put a random-access stream of data—it can be in the file containing the movie, a nearby file, or even a file elsewhere on the network! If more than one media in the movie references the same data file, the different types of data may be interleaved within the file.

As Figure 2 shows, each media is associated with exactly one track and vice versa. Because the track can map nonlinearly to the media (as is the case in Figure 2), you can edit a movie by simply changing a few pointers rather than having to move large pieces of data around. Two or more tracks can be members of a movie's *alternate group*; when the user picks one of these tracks to be active, QuickTime does not use any of the other alternate tracks.

Each media references "raw" data of one type—for QuickTime 1.0, either video or sound. It also contains its duration, time scale, priority, language, quality, media type, and handler. The media handler knows how to play back its data at the right time.

The *poster* is the single frame (in the movie) that the creator of a movie considers as best conveying the spirit of the movie. You can think of it as the frame you would like to show if motion were not possible—for example, when printing the document that

One common use for alternate audio tracks is to let the user watch the movie in the (human) language of her or his choice—for example, tracks 4 and 5 in Figure 1. A movie could also contain alternate video tracks—for example, tracks to be played using hardware decompression (for one track) or software decompression (for the other). In such a case, the video would play on any Macintosh with QuickTime, but it would play better on one with hardware decompression. •

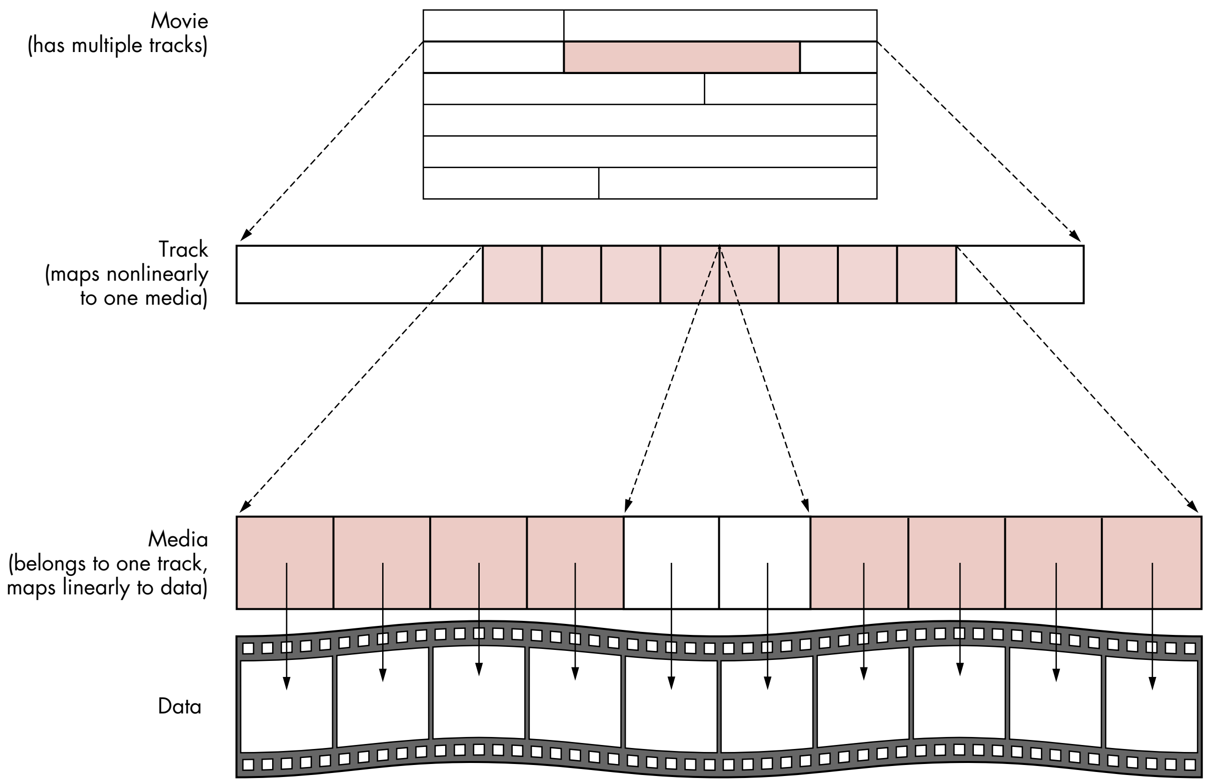


Figure 2
Basic Components of a Movie

contains the movie. The poster is usually a frame from the movie the user sees, but it can be an arbitrary frame from a video track that is not visible in the normal movie.

The *preview* is a short piece of the movie that best conveys the spirit of the movie. Note that although a preview is associated with a movie, the data (frames) associated with the preview may not be part of the movie the user sees. In movie terms, the track associated with the preview may not be part of the regular movie playback.

Although in the normal situation a movie file contains the data for its tracks (in which case it's called *self-referenced data*), it's possible for the data associated with a media to reside in a file separate from the movie, anywhere on the network.

Future releases of QuickTime are expected to extend the referencing capabilities of media to allow for data being acquired as the movie plays along—as, for example, data coming from a CD player or a video digitizer board.

To recap: A movie may contain any number of tracks. These tracks do not need to be playing at the same time, and as a matter of fact, a track doesn't need to become active at all. Several tracks can belong to a movie's alternate group, and only one of them can play at a time.

COMPONENT MANAGER

One very important architectural feature of QuickTime 1.0 is its extensibility. Let's take a video track as an example. When the Movie Toolbox (the subset of QuickTime that deals with movies) finds out it needs to play back this track, it calls the video media handler (which is a component). The handler in turn calls the Image Compression Manager, telling it the type of compression used. The Image Compression Manager then calls the Component Manager to find out if a corresponding decompressor component is available. If so, the Image Compression Manager can use this component without having to know all the details about the particular decompressor component needed. Of course, this is just one example; several different compression and decompression techniques are available, and the Component Manager allows the caller to choose a certain type of component by supplying additional information about it.

Let's study the decompressor component with subtype 'rpza', which has the following structure:

```
ComponentResource:
ComponentDescription        /* Registration Parameters */
   componentType:                imdc
   componentSubType:             rpza
   componentManufacturer:        appl
   componentFlags:               0x00000447   /* binary 0100 0100 0111 */
   componentFlagsMask:           0
resourceSpec                /* resource where component code is found */
   type:  cdec              /* the code is in a resource of type 'cdec' */
   id:    0x000A            /* with id of 10 */
resourceSpec                /* resource with name string */
   type:  STR               /* 'STR ' resource */
   id:    0x000B            /* with id of 11 */
resourceSpec                /* resource with info string */
   type:  STR               /* 'STR ' resource */
   id:    0x000B            /* with id of 11 */
resourceSpec                /* resource with icon */
   type:  ICON              /* 'ICON' resource */
   id:    0x000B            /* with id of 11 */
```

The registration parameters allow the Component Manager searching for a component of type 'imdc' (image decompression) to narrow the search to a component of subtype 'rpza', made by 'appl' (Apple Computer, Inc.). The parameters include the componentFlags and componentFlagsMask fields, which help determine how to search for a given component. Note that the subtype field can be omitted if no more information is considered necessary for the type of component in question.

For example, the componentFlags field in the example above indicates that the decompressor can do the following:

bit 0	scale on decompress
bit 1	mask on decompress
bit 2	use matrix for blending on decompress
bit 6	spool (used for compression and decompression)
bit 10	do fast dithering

The cleared bits have meaning, too. For example, the cleared bit 3 means that this component cannot use a matrix for the placement and scaling of the decompressed image.

The ComponentResource (shown above) also contains the type and ID of the resource where the code that performs the actual work is located. In addition, it contains the type and ID for resources containing the name string, info string, and icon associated with the component.

In short, the Component Manager can help applications access certain services by function rather than by name; Figure 3 shows how an application can call the Component Manager to interact with different types of components. When an application registers a component, it's guaranteeing that the component supports the basic set of calls defined for the type. This enables applications to find components by their function without having to know exact names or locations.

COMPRESSION AND DECOMPRESSION

Following the basic concepts of the Component Manager, the Image Compression Manager provides applications with a common interface to compression and decompression "engines" that's independent of devices and drivers. Figure 4 shows how the Image Compression Manager interacts with the Movie Toolbox, the Component Manager, and the application.

The services provided through the Image Compression Manager allow applications to compress still images as well as sequences of images (such as those found in video track media). In the case of image sequences, the Image Compression Manager also provides optional support for the *differencing* of frames—that is, storing only the pixels that differ from the previous frame to reduce the size of the movie data.

Given that these compression techniques are tightly coupled to the type of data they're supposed to handle, the Image Compression Manager does not work for sound, text, or any type of data other than images.

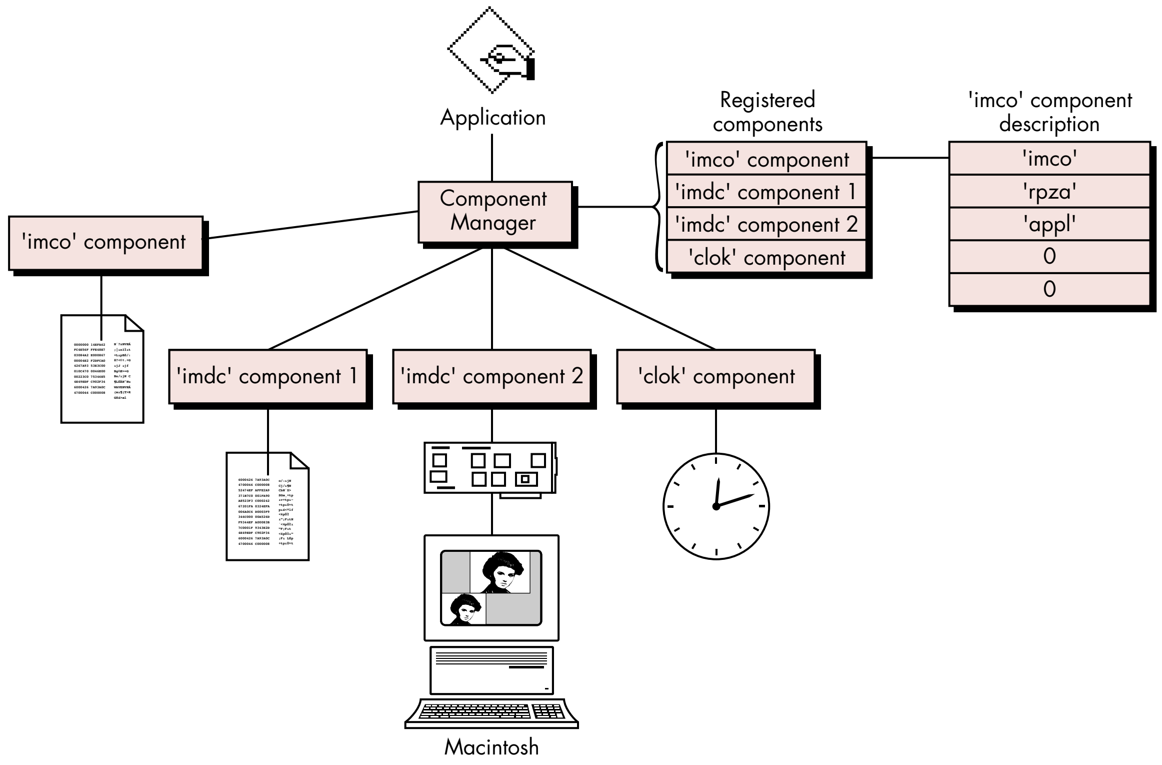


Figure 3
Component Manager Interactions

The Image Compression Manager accepts the input data as either a PICT or a pixMap; obviously, the first format is most often used for still images and the second for sequences of video. Since images can be very large (even when compressed), in both cases the Image Compression Manager allows for the calling application to provide spooling routines that feed the Image Compression Manager source data as needed and write the resulting compressed data to disk. The Image Compression Manager can also translate between pixMaps of varying bit depth. This simplifies the manipulation of an image split across monitors of two different bit depths; it also extends a compressor or decompressor's ability to manipulate images that (because of incompatible pixel bit depths) it would otherwise not be able to handle.

In the case of pictures, the Image Compression Manager provides a set of high-level calls that allow applications to compress and play back PICT resources and files. Although these compression facilities are available to applications that call them, even applications that know nothing about QuickTime's compression facilities can play back pictures containing compressed images. (This can occur because QuickTime-unaware applications calling DrawPicture will automatically invoke the

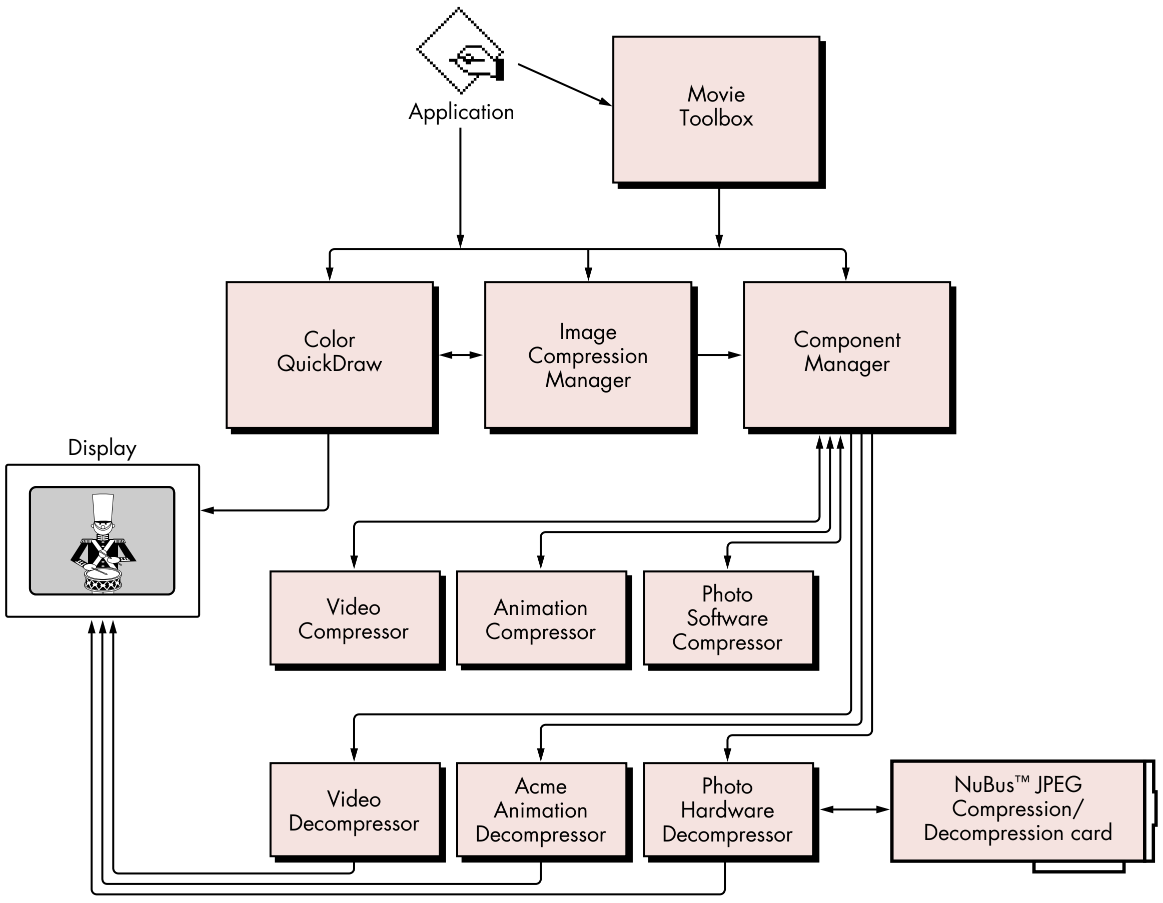

Application
Movie Toolbox
Color QuickDraw
Image Compression Manager
Component Manager
Display
Video Compressor
Animation Compressor
Photo Software Compressor
Video Decompressor
Acme Animation Decompressor
Photo Hardware Decompressor
NuBus™ JPEG Compression/ Decompression card

Figure 4
Image Compression Manager Interactions

Image Compression Manager, which will decompress the image automatically and hand the application the uncompressed PICT image it was expecting.) In other words, when QuickTime is present, you can use compressed PICTs as part of your application and know that any PICT-reading application can open them correctly.

The Image Compression Manager provides a simple and at the same time powerful system for compressing images. Since the mechanism is based in the workings of the Component Manager, adding new compression engines is as simple as dropping a 'thng' file into the Extensions folder of the System Folder (for System 7.0, or into the System Folder itself for System 6.0.7). Even when the exact decompressor component is not available to decompress the data, the Image Compression Manager will find a substitute if any is available. High-level calls are provided for applications to access these features in a nearly effortless manner.

QUICKTIME SAMPLE CODE

We'll now directly explore the QuickTime features that you can immediately put into your applications. We'll follow two samples, each of which accomplishes one of the two basic QuickTime functions: *playing back* a movie (which most applications should be able to do) and *creating* a movie (which you'll need to know how to do if your application creates new movies).

PLAYING BACK A MOVIE

To show the basic steps necessary to open movie files and play them back, we'll use the sample application SimpleInMovie. (You can find the source code for this on the latest *Developer Essentials* disc.) This program presents the user with a dialog for opening a movie and plays the movie back in a window. SimpleInMovie uses QuickTime's standard movie controller (which is itself a component) to let the user start or stop the movie as well as scan back and forth within it. Some commands for the movie controller are implemented as menu commands to show how a program can control the controller component.

But first, a few words . . . Before we look at the SimpleInMovie source code, we need to make several new distinctions. The most important distinction is that of a *public movie* versus a *playable movie*. A playable movie is what the Movie Toolbox manipulates; it has all the information needed for it to be played or edited. In contrast, a public movie is used only for data interchange, and it contains all the information needed to create a playable movie. A playable movie must be converted to a public movie (which is stored as a resource of type 'moov', pronounced "moo-vee") before it can be stored to disk or put into the Clipboard. QuickTime provides two calls to convert between the two forms: GetMoviePublicMovie converts a public movie into a playable movie, and MakePublicMovie does the opposite.

To summarize, a playable movie is what the Movie Toolbox plays back; it has all the media handlers instantiated and is ready to go. A public movie is strictly a static representation used when the movie is to be transferred or copied.

QuickTime gives you wide latitude in choosing the location of the raw data associated with a media, so we need to look at a few alternatives. A movie file has a file type of 'MooV'. We'll call a movie file "normal" if it contains exactly one 'moov' resource.

A movie file whose data fork contains only the media data referenced by the movie and no more is called a *flattened movie*. Specifically, it does *not* contain media frames that aren't referenced by the track to which they belong—for example, the unshaded media frames in Figure 2. A flattened movie is handy for transporting a movie *in toto* to another Macintosh computer. QuickTime provides a FlattenMovie call to create such a movie file.

A movie file containing multiple 'moov' resources would be atypical. In such a case, the application must inform the user of the existence of multiple movies and give the user a way to choose one of them. The Movie Toolbox can handle such files, but Apple discourages you from creating them. Most applications will just use the first 'moov' resource found in the movie file.•

The *single-fork file* is another type of movie file. Here, not only the media data but also the 'moov' resource data are in the file's data fork. (You might use a single-fork file when exporting to a non-Macintosh computer that doesn't have separate data and resource forks.) You can make a single-fork file by calling FlattenMovie with the proper parameters. QuickTime can automatically read these files.

Another possibility is that the movie's media point to data that are not in the movie file's data fork but in a different file; this is very common when you're about to edit a movie. Remember that to edit a track, you need only change pointers to the media; if you had to cut/copy/paste the actual image data (which can be multiple megabytes in length), editing operations could take an inordinate amount of time and disk space.

Back to the code. We can now proceed to examine SimpleInMovie's source code. Note that in the listing below, the comments help describe only those calls that have directly to do with playing movies. The full source code of this program (on the *Developer Essentials* disc) contains numerous other comments on the details that pertain to all normal Macintosh operations.

As is the case with most parts of the Macintosh Toolbox, the Movie Toolbox has to be initialized. In our sample, the initialization is done as follows:

```
void InitMovieStuff()
{
ComponentDescription   controllerDescriptor;
long                   version;
extern Boolean         DoneFlag;
extern Component       movieControllerComponent;

   /* We have to fill in the fields for the player descriptor in order
      to get the standard movie controller component. */
   controllerDescriptor.componentType = 'play';
   controllerDescriptor.componentSubType = 0;
   controllerDescriptor.componentManufacturer = 0;
   controllerDescriptor.componentFlags = 0;
   controllerDescriptor.componentFlagsMask = 0;

   /* We'll use gMoviesInited as a flag for everything; false means that
      the Movie Toolbox or standard player couldn't be initialized. */
   gMoviesInited = false;             /* so pessimistic */

   if (!(Gestalt(gestaltQuickTime, &version)))
      if (!(EnterMovies()))
         if (movieControllerComponent = FindNextComponent((Component)0,
               &controllerDescriptor))   /* No error means we're OK. */
            gMoviesInited = true;       /* Good! */
```

```
    if (!gMoviesInited) {
        Alert(rBadMooviesALRT, nil);   /* Inform user we're bailing out. */
        DoneFlag = true;
    }
}
```

EnterMovies initializes the Movie Toolbox. In an application, this must be balanced by ExitMovies (or Bad Things will happen to your application). If you're calling EnterMovies from a nonapplication environment (such as an XCMD), *you* must call ExitMovies to balance the calls and ensure that all memory allocated and all globals are disposed of.

Normally, when an application presents a movie, it also wants to give the user some basic control over the playing of the movie. QuickTime provides a tool that lets developers add such control easily: a component called the *standard movie controller* (the horizontal bar at the bottom of the window in Figure 5).

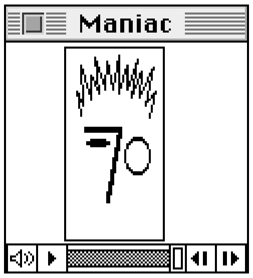


Figure 5
The Standard Controller

Getting and using the component. To use a component, you first have to get it, which means you must fill in a ComponentDescription. Our example specifies only the basic type, but the subtype, manufacturer, and flags fields allow you to specify the component in greater detail. If, for example, you were looking for a compressor, the type would be 'imco' for an "image compressor" or 'imdc' for an "image decompressor." In addition, the subtype could be 'rpza', 'rle ', or 'jpeg' (or others), each of which specifies a specific implementation of compression or decompression.

Although an application can register components "live" (that is, after the application has started up), the normal way they get registered is during system startup, at which time the Component Manager registers all components found in files of type 'thng' in the Extensions folder of the System Folder (for System 7.0, or in the System Folder itself for System 6.0.7). Because this happens automatically, the application can find a specific component by making the following call:

```
FindNextComponent((Component)0, &controllerDescriptor);
```

This call tells the Component Manager to find the component that matches the descriptor (controllerDescriptor); passing 0 in the first parameter tells the Component Manager to return the first one of this type that it finds. In the case of a more extensive search, you may want to continue the search; you would then pass the last component found to get the next in the list that matches the descriptor.

Once you know that the component exists, you have to open it. A component (if it's so designed) can be accessed multiple times simultaneously. Each time a component is opened, the calling application receives what is known as an *instance* of the component. The instance is what the application uses to maintain communication with the component. In our sample, we get an instance of the standard movie controller by calling OpenComponent(movieControllerComponent), where movieControllerComponent is the value returned by FindNextComponent. So keep in mind that there's a difference between a component and an instance of the component.

Once we've done the initialization, the user can select a file, and we can then proceed to set up showing the movie. The code that gets the movie looks like this:

```
if (OpenMovieFile(&(reply.sfFile), &movieResFile, fsRdPerm, nil)) {
   DoReportFailure();
   return;              /* and go back */
}
else {
   if (!(err = NewMovieFromFile(&moov, movieResFile, &resID, nil,
         0, &wasChanged))) {
      if (err = GetMoviesError())
         DebugStr("\perror after NewMovieFromFile");
   }
   else {
      DebugStr("\pCould not get the moov ");
      err = -1;       /* err set will make it skip the rest */
   }
   CloseMovieFile(movieResFile);
}
```

Given an FSSpec (which, in this example, is reply.sfFile), the call OpenMovieFile returns the reference number for the resource fork of the file, once it has been opened. (In the code above, the reference number is in the parameter movieResFile.) It can also return the data reference for the movie, but in this example we pass nil, which indicates that we don't need it; we would need it if we were going to add tracks to the movie. (Later in this article, the section "Creating a Movie" gives more details on data references.)

Once the resource fork is open, we call NewMovieFromFile, which when successful returns the *playable* movie. NewMovieFromFile first gets the 'moov' resource (which is a public movie), creates a movie, and then resolves its data references.

Apple has provided calls such as OpenMovieFile and NewMovieFromFile to simplify things for you. Though it is possible for you to make the low-level calls needed to make a playable movie from a public one, we don't recommend it. You run the risk of confusing the Movie Toolbox, which may result in incorrect values for the self-referenced data references (which indicate that the data is in the same file as the 'moov' resource). Both OpenMovieFile and NewMovieFromFile handle this situation correctly when they resolve the data references.

In our sample, when calling NewMovieFromFile, we pass 0 for the ID, meaning that we'll take the first 'moov' resource found. We also pass nil for a name pointer, since we don't plan to display the name or change it. We proceed to close the file by calling CloseMovieFile. (If we were editing the movie, we would not close the movie file here.)

Now that we have a movie, the next step is to adjust the movie box so that the movie appears in the right place in our GWorld (the window in which the movie appears):

```
GetMovieBox(moov, &moovBox);    /* Get the movie box. */
OffsetRect(&moovBox, -moovBox.left, -moovBox.top);    /* topleft=0 */
SetMovieBox(moov, &moovBox);
```

What is a movie box? Figure 6 shows how the Movie Toolbox calculates the rectangle known as the *movie box* and displays a multitrack movie in an application's window.

- *Pieces 1 and 2*: For each track, the Movie Toolbox takes the intersection of the source rect of the track and the track's clip region (both of these entities share the same coordinate system). The resulting area is transformed into the movie's coordinate system using the track's matrix. In piece 1, the track's clip region is smaller than the image. The clip region of piece 2 is the same size as the track's source rect.
- *Piece 3*. The MovieSrcBoundsRgn is the *union* of all the clipped track regions. In this example, there are two regions. Note that the MovieSrcBoundsRgn includes both the striped and unstriped parts of piece 3.
- *Piece 4.* The MovieSrcClipRgn is the region in which the Movie Toolbox is to display the movie. It clips the image to the areas marked with diagonal and vertical stripes.

- *Piece 5, 6, and 7.* Piece 5 is the image resulting from the intersection of pieces 3 and 4. The MovieBox, piece 7, is the minimum rectangle that contains piece 5, mapped into the local coordinates of piece 6, the MovieGWorld (which belongs to the application that's showing the movie).
- *Piece 8.* The MovieDisplayClipRgn is the last clip applied to the movie before it's displayed.
- *Piece 9.* The application displays only the intersection of pieces 7 and 8, which includes the minimal rectangle enclosing the diagonally and vertically striped areas.

When QuickTime plays a movie, it doesn't take the GWorld's clip region into account; the GWorld's clip takes effect at the level of the application running the movie. If your application draws into the window where a movie is playing, you want to be sure that the MovieGWorld's clip region *excludes* the part being drawn by the Movie Toolbox; in Figure 6, this would be the striped regions within piece 8 *and* the smallest rectangle that contains them.

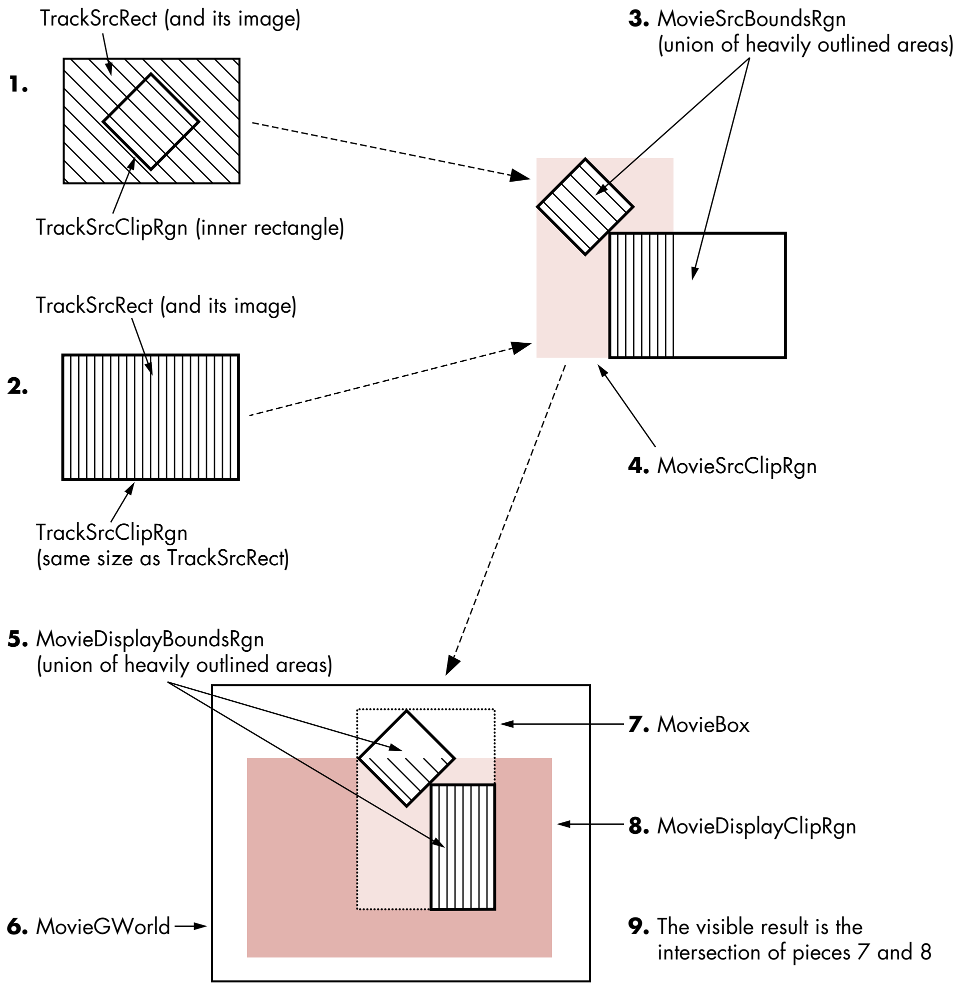
The last clip applied by the Movie Toolbox occurs when it applies the *movie display clip region* (piece 8 in Figure 6). This clipping area is not, in the strict sense of the word, part of the movie; it is only a run-time option and is not saved in the public movie. (This allows your application to apply a final clip of the movie within your application's GWorld.) If, for example, you used a triangular movie display clip region to clip a larger movie image, the movie would appear in its window as shown in Figure 7.

Now that such an important question has been taken care of, we can go back to the sample code. The main idea here is that the movie box probably does not have its top left corner set to (0,0). So if left to chance, the movie may not be visible in the GWorld (CGrafPort) used to display it, since its coordinate system is the GWorld's. The code then translates the resulting movie to the top left corner of our window, thus ensuring that it will be visible. Figure 8 shows how the movie box can also be used to scale the resulting image.

Our sample application then creates a window for the movie and stores with it the player instance (obtained by calling OpenComponent(movieControllerComponent)) and the movie associated with that window.

Adding the controller. Then we call MCNewAttachedController. The objective here is to put together the movie, the player instance, and the window. Although we recommend that you use the standard controller, it's not the only way to control movies; you can do it all "by hand" if you want tighter control—but you must be careful to do it right.

For your information, the "MC" in QuickTime-related names stands for "Movie Controller."•



TrackSrcRect (and its image)
1.
TrackSrcClipRgn (inner rectangle)
TrackSrcRect (and its image)
2.
TrackSrcClipRgn
(same size as TrackSrcRect)
3. MovieSrcBoundsRgn
(union of heavily outlined areas)
4. MovieSrcClipRgn
5. MovieDisplayBoundsRgn
(union of heavily outlined areas)
6. MovieGWorld
7. MovieBox
8. MovieDisplayClipRgn
9. The visible result is the intersection of pieces 7 and 8

Figure 6
Displaying a Multitrack Image in an Application's Window

MCNewAttachedController sets the destination window as the GWorld for the movie and for the drawing of the control, and it attaches the control instance to the movie being played.

Then we must call SetMovieActive to enable the movie to be serviced by calls to MoviesTask; StartMovie then sets it in motion. MoviesTask has to be called periodically (normally as part of the normal idle processing in the event loop) for the movie to display successive frames without erratic playback.

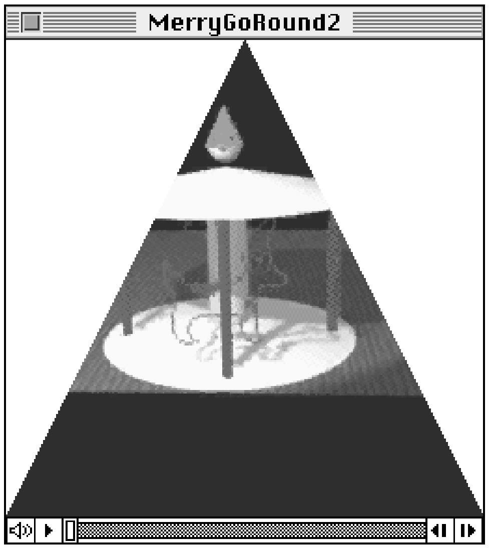
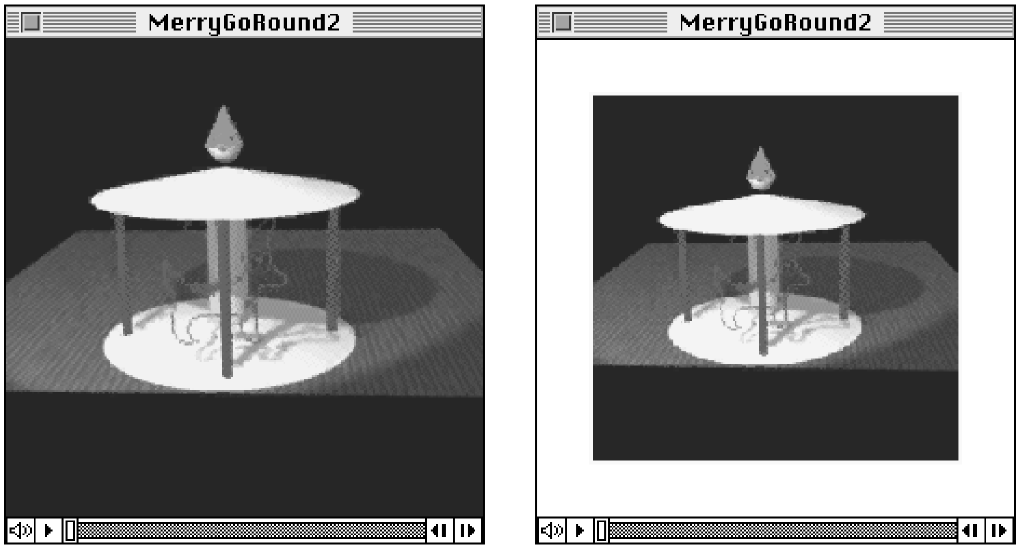


Figure 7
Movie Clipped by Display Clip Region



Original movie

Same movie after
`InsetRect(&moovBox, 30, 30);`
`SetMovieBox(moov, &moovBox);`

Figure 8
Changing the Movie Box

Since in our sample we're using the standard controller, we call instead MCIsPlayerEvent, which accomplishes the following: First it calls MoviesTask to keep the movie (or movies) in motion. Then it performs the tracking of events that belong to the controller itself (such as button clicks and moving the scroll box as the movie moves along).

To summarize, the basics of including playback of movies in an application are as follows:

- Get a public movie and convert it into a playable movie.
- Associate the movie to the GWorld that will display it.
- Set the movie in motion.
- Periodically call MoviesTask to keep the movie in motion.

The above is, necessarily, a simplistic description of the process. By reading QuickTime's documentation, you'll find that the set of calls range from the very high-level, such as when using the standard controller and the movie file calls, to the fine-detail calls that allow you to control the movie at the track level, as well as intermediate-level calls that allow you to control and monitor such movie parameters as the rate (speed) of the movie and its sound level.

CREATING A MOVIE

The sample source code that we'll use to discuss the creation of a movie is called SimpleOutMovies. This program creates a movie that contains two tracks. The first is a video track made out of frames that are read in from PICT files (this is what you must do to create a movie from a sequence put together using a rendering package like MacRenderMan®). The second track uses the data contained in a 'snd ' resource to add sound to the movie.

Again, we won't dwell here on the details that aren't pertinent to the creation of movies. The curious reader is once more invited to check out the source code files on this issue's *Developer Essentials* disc for the whole story. I can't help mentioning that the file-handling part of the code demonstrates how to let the user select a folder and then access the files in it sequentially; I found writing this an interesting exercise.

SimpleOutMovies first calls the usual initialization stuff, including (since we're QuickTime savvy) EnterMovies, the call that initializes the Movie Toolbox. Then it proceeds to prompt the user to indicate where to put the movie file and what to call it, followed by a prompt to find the folder with the PICT files. The program also creates a window to display the frames as they're processed, sizes the window according to the frame of the pictures, and starts the real job.

The code looks like this:

```
theErr = CreateMovieFile(&mySpec, 'TVOD', 0, cmfDeleteCurFile);
if (theErr) DebugStr("\pCreateMovieFile Failed");
theErr = OpenMovieFile(&mySpec, &resRefNum, fsRdWrPerm, &mdrh);
if (theErr) DebugStr("\pOpenMovieFile Failed");
```

After calling CreateMovieFile (passing the FSSpec corresponding to the file the user wants to create), we call OpenMovieFile. Although we discussed this call earlier, there's an important difference: Now we want to use the media data reference (held, in the code above, in the parameter mdrh).

A *media data reference* is what the Movie Toolbox uses to find the location of the data for a given media. In this part of the example, we want to add the data to the same file we're creating. That's why it's important that, when the call returns, the parameter mdrh contains the reference to the file being created. Remember that this type of data reference is called self-referencing because it points to its data as being in the same file as the 'moov' resource. In the case where the data for a track resides in a different file, it's necessary to create a new data reference that points to that file.

Once the file has been opened, we create the movie by calling NewMovie(0, 60). This creates an empty movie (devoid of tracks) but one that you *could* play (with, however, little result). In other words, NewMovie creates what I've been calling a *playable* movie. The parameters indicate that we want the movie to be created inactive and that the TimeScale for the movie is 60—in other words, each unit of time in the movie is 1/60th of a second, equivalent to a Macintosh "tick." (I might add that each track has a TimeScale associated with it, but the Movie Toolbox takes care of synchronizing the individual times.)

Next, we create the video track based on the following two lines of code:

```
gTrack = NewMovieTrack(gMovie, 0, kTimeScale, frameX, frameY);
gMedia = NewTrackMedia(gTrack, VIDEO_TYPE, mdrh, kTimeScale);
```

A track contains bookkeeping information associated with the track's overall data content. For example, to the new movie track we feed in the following: the movie the track is part of (in the above code, gMovie), the time offset (0), the scale for the track (kTimeScale), and the dimensions of the frames as obtained from the PICT frame (frameX and frameY). kTimeScale in this case is set to 10 (which means that the time unit for the track is 1/10th of a second).

Then we create the media associated with the track by calling NewTrackMedia. The parameters establish the type of the media (currently the types defined are VIDEO_TYPE and SOUND_TYPE; new types will be announced as they're defined) and, of course, the time scale for the media. For the last parameter in our

It's important to note that the time offset is given in movie time; since we want the track to start from the beginning of the movie, we pass 0 to NewMovieTrack. Nothing prohibits a track from starting at a time different from 0; if we wanted this track to start two seconds into the movie, we would pass an offset value of 120.•

example we again pass kTimeScale—same as for gTrack—but this is not required; the media can have a different rate than the associated track. The Movie Toolbox provides many calls that allow you to convert between times and rates for those cases when this is necessary.

The next call to the Movie Toolbox is

```
BeginMediaEdits(gMedia);
```

This call is needed here because we're going to add data to the media; in other words, the data comprising the samples will be moved into the media's data file. We'll see that when adding samples by reference (when the data doesn't move), BeginMediaEdits is not necessary.

Capturing the video track. We're now ready to start collecting samples for our video track; enter the Image Compression Manager, stage left. In most cases it's desirable to compress the images to minimize both the size of the resulting file and the amount of data that needs to be moved when playing back the movie.

After we allocate a buffer that can contain the images we want to use, we call

```
GetCompressionSize(&pm, &r, theDepth, theQuality, codecType, codecID,
                   &maxCompressedFrameSize)
```

The purpose of this call is to find out, using the known parameters for the images, an estimate of the worst-case size for the resulting image. (In the same manner, GetCompressionTime can return information concerning the *time* that it would take to compress the image.)

After allocating the buffer for the compressed data, we call

```
CompressSequenceBegin(&seqID, &pm, nil, &r, nil, theDepth, codecType,
                      codecID, theQuality, mQuality, keyFrameRate, ct,
                      codecFlagUpdatePrevious, imageDescriptorH);
```

The parameter seqID points to a variable where the ID of the sequence is stored. This value is needed to continue adding frames to the sequence. We pass nil for both the previous pixMap and rectangle; this indicates that the Image Compression Manager will allocate the GWorld to keep a copy of the image against which the next frame will be compared. If you wanted to allocate it yourself, you would pass it here.

The overall objective of the code that creates this video sequence is, when going from frame to frame, to store as little information as possible for each new frame. Instead of storing a complete image for every frame, we want to add only the difference between a given frame and the *key frame* (the most recent frame that contains the complete image).

The Movie Compressor component has a built-in decision maker that determines when a new key frame is needed. Nevertheless, based on the expected images, the program can set the maximum number of frames that can be added before a new key frame is needed. In our case, we pass a value of 10 for the keyFrameRate, which means that at least every ten frames a key frame of the entire image has to be added to the sequence. If you want to force the creation of a new key frame *every* frame, you can easily do this by calling SetCSequenceQuality and passing 0 for temporalQuality.

The last parameter to mention is the ImageDescription handle. This handle (which the calling program has to preallocate) is filled in by the compressor and contains all the information necessary to reassemble the image. The ImageDescription handle is required by the media to interpret the data. Later, when we add sound to this movie, we'll see how this is handled differently.

Then our code renders one picture in the off-screen GWorld allocated for this purpose and calls

```
CompressSequenceFrame(seqID, &pm, &r, codecFlagUpdatePrevious,
         *compressedFrameBitsH, &compressedFrameSize, &similarity, nil);
```

followed by

```
AddMediaSample(gMedia, compressedFrameBitsH, 0L, compressedFrameSize,
              (TimeValue)1, (SampleDescriptionHandle)imageDescriptorH,
              1L, similarity?sampleNotSync:0, &sampTime);
```

Very similar to CompressSequenceBegin, CompressSequenceFrame adds more frames to a sequence. Note that we have to pass the sequence ID, the ImageDescription handle, and a VAR parameter named "similarity," which tells how close the current frame is to the previous frame (the values range from 0, which means a key frame was added, to 255, meaning that the two frames are identical). The compressor has one flag, codecFlagUpdatePrevious, which tells the Image Compression Manager to copy the current frame to the previous frame's buffer.

This process is repeated for each frame and, when all the PICTs have been processed, we close the sequence and add the media to the movie:

```
CDSequenceEnd(seqID);
EndMediaEdits(gMedia);
InsertTrackMedia(gTrack, 0L, GetMediaDuration(gMedia), 0L,
                 GetMediaDuration(gMedia));
```

The important call here is InsertTrackMedia. This call is the final link in adding samples to a track. When EndMediaEdits executes, the new data samples are already part of the media. However, the track does not know about the additions that have just been made, and the call to InsertTrackMedia takes care of that. There are numerous implications here, but an interesting one is that a segment of the media can be inserted into the track more than once. Since the time scale of the media and track are the same, we can use the value of the media's duration for the track segment's duration, too.

At this point we have completed the creation of a movie and have added a video track to it, so we end with the following:

```
AddMovieResource(gMovie, resRefNum, &resId, (char *)sfr.fName);
CloseMovieFile(resRefNum);
```

That's it—we have a movie that we can play. But we're missing one thing: sound. This is not a big deal, since adding sound is very much like what we've just done. In the paragraphs below, we'll describe what's different.

Adding sound. Before closing the file in our sample program, SimpleOutMovies, we must include the routine that handles adding the sound. The process is the same as it was for video. In this case, the user is prompted for a file containing a sound resource. When selected, the program reads in the 'snd ' resource and, with that data at hand, we proceed to fill in the sound description record.

In the QuickTime 1.0 release, the Movie Toolbox can deal only with sound data made out of sampled sounds; any other data will make no sense. Future releases of QuickTime will most surely have support for other sound formats. This is why most of the fields in the sound descriptor record have to be filled with zeros; but based on the 'snd ' data, we enter the number of channels, the sample size (in bits), and the frequency of the sampled sound.

Then we start again with

```
NewMovieTrack(moov, (TimeValue)0, kTimeScale, 0, 0);
```

Note that for a nonvideo track, the spatial information width and height must be set to 0. Since we're adding sound that has been sampled at a rate of 11 kHz, the constant kTimeScale has been set to this value.

The call to create the new track is followed by

```
NewTrackMedia(gTrack, SOUND_TYPE, mdrh, kTimeScale);
```

Note that we're still using the same media data reference that we used for the video track; this means that we want to continue adding samples to the same file, since that's where the parameter mdrh points.

After this we call BeginMediaEdits to start adding samples, followed by AddMediaSample, EndMediaEdits, and InsertTrackMedia. The difference in this sequence is that AddMediaSample is called only once; since all the sound data is in one place, we add it all at once.

Finally, what happens when we don't want to add the data directly—that is, when it's in a file and we don't want to copy it over to the movie file? In this case we need to add data by reference and first we need to create a media data reference record. Although these calls are System 7.0-specific, QuickTime makes sure they work when running under System 6.0.7.

In this case, our program goes through the same process as before, asking the user to select a file with sound data in it:

```
SFGetFile(dlgPos, "\pSound file:", nil, 1, &typeList, nil, &reply);
```

where "reply" is an old, trusted SFReply. Once the user selects the file, we call

```
FSMakeFSSpec(reply.vRefNum, 0, (unsigned char *)reply.fName, mySpec);
```

passing a pointer to an FSSpec in mySpec.

When we have the FSSpec that describes our sound file, we have to make an alias to it. We do this by calling

```
NewAlias(nil, &mySpec, &SoundFileAlias);
```

From the alias, we create a media data reference by calling

```
mdrh = NewDataRef(SoundFileAlias);
```

We then use the parameter mdrh to create the media (gMedia) and immediately call

```
AddMediaSampleReference(gMedia, 0, fSize, (TimeValue)1,
       (SampleDescriptionHandle)sndDescriptH, nSamples, 0, &sampTime);
```

Note that we pass 0 for the location of the data within the file; fSize is the size of the samples. If the file cannot be found when opening the movie, the user will be prompted to locate the missing file. Since we are not adding the sample data directly, it's not necessary to call BeginMediaEdits and its companion EndMediaEdits.

We did not have to add the sound all at once; it would have been possible to have added samples in smaller chunks if this had been appropriate. One such example would have been to allow the Movie Toolbox to play the sound track by reading in parts of it as needed (instead of all at once). The other side of the coin is that there would be more accesses to the disk and, in instances when the disk media is slow, this could cause a performance degradation. It's recommended that when you create movies, you perform some tests to find the balance that provides the best results. •

So now you know how to create a movie file and then the movie itself; you start out with an empty shell that you must then fill by creating tracks and media. This sample program also shows how to add media, both directly and by reference.

WHAT'S LEFT?

QuickTime comprises over 500 calls, and it was never the intention of this article to detail them all. We hope that after reading this article, you will see great possibilities for QuickTime and will continue collecting information about this new and exciting technology. Who knows, maybe next time "I'll see *you* in the movies!"

QUICKTIME AND THE HUMAN INTERFACE

DISTILLED WISDOM FROM THE QUICKTIME HUMAN INTERFACE GROUP

The discussions we've had of QuickTime-related human interface issues could fill more than a thousand books; below are the main recommendations for a good interface. Most of these guidelines for using movies come from the maxim "put the user in control." Our user-testing has shown that more often than not you really do need to do the following things to keep your users happy.

- Users should be able to look at the screen and figure out which images are movies.
- A movie should open with its poster showing; if it has no poster, its first frame should be shown. Upon first playing, the movie should make a visual transition from the poster state to the movie state. To get back to the poster, users may reset the movie to the beginning.
- If you allow users to resize movies, the movies should by default maintain their original aspect ratios.
- Where it makes sense, make handling movies as much like handling conventional (static) graphics as possible. For example, in your word processor, resize movies the same way you do pictures.
- Movies should not play when a document is opened.
- Users should be able to find the controls for playing any movie easily.
- It should be reasonably obvious not only how to turn the movie on, but also how to turn it off.
- There must always be an easy and immediate way to stop a movie that's playing.
- There must be at least a sound mute control, and preferably a volume control. The sound tracks of different movies will have different sound levels, and movies will be played back in different environments—some that can tolerate loud playback and others that cannot. Also, it's highly desirable that users have a convenient way to adjust the volume of sounds that accompany the movies. The Sound Control Panel is not judged to be adequately convenient for this purpose.
- In most applications, single-clicking a movie must select it, not play it. This allows users to perform operations on the movie such as Cut, Get Info, "hide controls," "resize," or any number of other operations that your application might support.
- Double-clicking a movie may cause it to play, but only if subsequently single- or double-clicking stops it (you have to test for and ignore any immediate second click because many users double-click reflexively).
- If you don't need single-clicking to select a movie, single-clicking may begin the playing of the movie—just as long as single-clicking also stops it (and you dispose of double clicks, both for starting and stopping).
- Don't mix movies that *play* on single click with movies that *select* on single click.

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