



Secrets of Cinelerra

History of Cinelerra

Many years ago when he was young and stupid, a young programmer used to spend hours and hours drawing storyboards, trying to simulate movies out of paper and pen, trying all kinds of character movements, camera angles, and ordering of events to convert mere visions into a living breathing experience for an audience. Those pages of storyboards would never become real movies but the obsession would live on. One day he thought, the technology would be available for anyone regardless of budget to put their dreams into live action.

In 1996 the first incarnation of that obsession came out: Broadcast 1.0. It was just a window with a waveform in it, it could cut and paste stereo audio waveforms on a UNIX box, except unlike other audio editors it could handle up to 2,147,483,647 bytes of audio. That was a feature normally only accessible to the highest end professional audio houses.

In 1997 Broadcast 1.0 was replaced by Broadcast 2.0. This time the window had a menubar, patchbay, console, and transport control. Broadcast 2.0 still only handled audio but this time it handled unlimited tracks, and it could perform effects on audio and save the resulting waveform to disk. More notably a few effects could be performed as the audio was playing back, in realtime, without writing to disk. A user could mix unlimited numbers of tracks, adjust fade, pan, and EQ, and hear the result instantly. Amazingly this real time tweaking is still unavailable on most audio programs.

But Broadcast 2.0 still didn't handle video and it wasn't very graceful at audio either. In 1999 video broke into the series with Broadcast 2000. This iteration of the Broadcast series could do wonders with audio and offered a pretty good video feature set. It could edit video files up to 64 terabytes. It could do everything Broadcast 2.1 did with audio except now all effects for video and audio could be chained and performed on the fly, with instant feedback as a user tweaked parameters during playback. Broadcast 2000 made it very easy to do a lot of processing and editing on video and audio that would otherwise involve many hours setting up command line sequences and writing to disk.

For a time it seemed as if the original dream of free movie making for everyone had arrived. Later on Broadcast 2000 began to come short. Its audio was pretty graceful. Its video was graceful if you knew how to use it efficiently, but quality issues and new user interface techniques were

emerging. Broadcast 2000 kept the audio interface from its ancestors, which didn't apply well to video. Users likewise were maturing. No longer would it be sufficient to just edit video on a UNIX box. Most users expected on UNIX the same thing they got in Win or Mac.

In mid 2000 designs for a Broadcast 2000 replacement were drafted. The Broadcast name was officially retired from the series and the software would now be called Cinelerra. Cinelerra would allow users to configure certain effects in much less time than required with Broadcast 2000. It would begin to emulate some of the features found in Win and Mac software while not attempting to become a Win clone. It's interface would be designed for video from the ground up, while supplanting that with the Broadcast audio interface. As always, quality improvements would happen.

Cinelerra is the first program not intended for consumer use. It was designed for a very small userbase which is concerned with high quality and high resolutions while the majority of UNIX users should use command line tools. Cinelerra was designed from the start for uncompressed HDTV and professional audio. In most cases the command line tools match the needs of the consumer level better than Cinelerra.

The linear approach to content creation

Most of you have probably chained two VCR's together in an attempt to cut out the commercials from a TV show. First you'd start the destination VCR in paused recording mode. Second you'd start playing from the source VCR until the start of the show. Right at the start of the show you'd hit pause on the destination VCR and record up until the first commercial started. Then you'd pause the destination VCR, fast forward the source VCR to the end of the commercial block, and resume the destination VCR right when the show continued. This would go on until the end of the show.

What if you played back the resulting tape and discovered an extra commercial which didn't get edited out? Say you passed out in the middle of a segment or you thought a commercial was part of the show. You'd have to shuttle the source deck to the end of the commercial, start the destination recording at the beginning of the commercial, and rerecord everything after that point to fix the problem.

This traditional process is usually called *linear* editing since it involves recording the destination program from start to finish in a straight line.

The Cinelerra approach to content creation

Cinelerra makes the traditional content creation process more like playing with legos. If you decide to insert an edit in the middle of the show, you merely have to insert another building block, and everything beyond that point is automatically shifted back. If you discover an unwanted commercial you can cut out a block from the middle of the show without rerecording anything, and everything else will back up to fill the gap. Cinelerra takes an entire video tape and digitizes it onto a hard drive so any segment can be accessed at any time, with no tape shuttling and no repeated transferring of data between machines.

More importantly as you edit with Cinelerra the changes are instantaneous. Cinelerra transparently maintains an *edit decision list (EDL)* in memory. This records every edit made on the show and reconstructs the proper frame order when playing back. Where every edit in the linear process requires transferring gigabytes of data either between VCR's or between files on a hard drive, Cinelerra redirects time codes in the EDL during the editing process. Only when the show is played back are the right frames loaded from disk for display.

It wouldn't be fair to call Cinelerra a pure video program. It handles audio just as well as it handles video. You can digitize an entire audio CD or tape onto a hard drive for immediate editing.

Keeping track of time

When dealing with multiple media types like audio and video the problem of synchronization arises. To keep the different media types synchronized a certain number of video frames have to be played during a certain number of audio samples and the numbers of each are usually fractional. The first step in reducing calculations and rounding errors is to have every media type refer to a common unit for measuring time. In designing Cinelerra a lot of agony went into deciding what unit time would be measured in. There were a number of possibilities with disadvantages and advantages:

Video frames: Units are too big. Doesn't allow editing audio

between frames. Unit size changes with project frame rate.

Audio samples: Smallest whole numbered unit available for measurement. Translating between samples and frames is never exact and causes rounding errors. Unit size changes with project sample rate.

Fractional seconds: Best precision . Fewer calculations involved in converting between samples and frames. Unit size is independent of project sample rates. No discrete increments.

With automatic sample rate and frame rate normalization in Cinelerra the time measurements had to be rate independent. At the same time measurements had to be discrete when identifying how long an edit of a certain media type was or how much to increment the time every time a sample was rendered in playback.

Cinelerra uses a hybrid measurement system. Where measurements have to be media independent we store time in fractional seconds. Where measurements deal only with a specific media type we use the native units for that media. Labels, in/out points, and selections are in seconds while lengths of edits and keyframes are in media units.

A session with Cinelerra