Multi-Channel Video Recording Systems for Multi-Camera Event Videography

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What is a multi-channel video recording system?

Although professional videographers and content producers are accustom to using 2 or more camcorders to obtain multiple camera angles during a shoot, a new category of affordable *multi-channel* video production recording systems has been developed that offer an alternative and a more efficient workflow for multi-camera productions. These recording systems provide the budget conscious videographer or small production company a more cost effective and faster way to go from shoot to delivery. It also can decrease staff requirements. These systems are capable of *simultaneously* recording at least four or more HD video sources with eight or more embedded audio channels. Each channel of video (with audio) is recorded at the same time as the other channels into its own individual video file on one media storage drive, as opposed to using individual media storage cards for each camera. Thus, keeping all footage together and in sync. Such systems currently are mostly PC-based, which use multi-channel capture cards from OEM manufacturers such as AJA, Blackmagic Designs, Bluefish444, Deltacast, Magewell, Matrox, Osprey, and Yuan. These card manufacturers usually provide some form of multi-channel recording application or SDK for a third party software developer.

FutureVideo, with its V-Station[®] HD range of DVRs, is pioneering this area for the videographer with multi-channel recording and play back "turn-key" systems that make the multi-angle video shoot—and post migration—easier than ever before. Such features include a media asset management system to organize and categorize the video and metadata into defined projects; multi-angle playback and editing on-set; XML project to the NLE system (Premiere Pro, Final Cut Pro, Vegas Pro); and many more useful capabilities than a simple capture software application can only do.

Other companies, such as Matrox, offer a "build it yourself" approach with its VS4Recorder Pro hardware/software bundle for Window's based PCs. which provide multi-channel synchronized recording, while Softron Media M| family of capture systems also provide similar features for Mac users.





Figure 1a. FutureVideo V-Station HD Pro4 System

Figure 1b. Matrox VS4Recorder Pro Hardware/Software

Although live video production systems from BlackMagic Designs (ATEM), Livestream (Studio), NewTek (Tricaster), Telestream (Wirecast), UStream (UProducer), and vMix(vMix GO) normally offer only single

channel HD recording of the mix, some do offer multichannel recording capabilities in the more heavily-featured versions (NewTek's Isocorder, Livestream's Studio HD series, and vMix's Multicorder). These systems were primarily designed for *live* multi-camera video production, wherein all video sources are fed into the multi-camera switcher (upstream) and the director determines which of the camera angles, B-roll sources, or graphic buffers are to be recorded during the shoot. In these, as well as other dedicated multi-camera production switchers from DataVideo, JVC, Panasonic, Roland, Sony, and others, only the single program (main) output of the switcher is typically recorded and not the individual camera angles.

In contrast to live production or the use of several independent single channel DVRs/camcorders, a multichannel video recorder can record all of the production's camera angles *simultaneously* on the same unit—plus B-roll content or other presentation graphics used during the live shoot. Later, in post-production the camera angle and edit decisions are made along with the addition of titles, graphics, transitions, and effects. Multi-channel video recording systems are designed to make the workflow process from shoot-to-post more flexible and efficient than would be possible with multiple camcorders. This is accomplished by synchronizing the videos during the shoot and providing better tools for transferring the project to post-production.

Multi-channel video recording systems can co-exist with live video production systems by splitting off each of the

Multi-Track Audio Analogy

An analogy to live multi-camera vs. multi-channel video production is single-track vs multi-track audio recording. Before there was multitrack audio recording, the mix was done live and recorded on a tape deck with one (mono) audio track. Consequently, a single voice or musical instrument in the original recording could not be independently accessed after the session ended. With the advent of multi-track audio recording, multiple channels of audio could be recorded unto individual audio tracks that later could be accessed, mixed to the appropriate levels, and equalized for the desired result. The digital age replaced analog tape machines with many more audio channels and an unlimited number of tracks. This is similar to a multi-channel video recording system. Each camera's output signal is fed into separate video channels and collectively recorded as synchronized files, then later are individually accessible. When the files are transferred to a post-production system, they can be mapped onto multiple synchronized video tracks, if desired.

camera sources to go to both the live and multi-channel recording systems. This way, should some failure occur in the live system mix, or the wrong angle was used, the original source footage is still available.

Why not just use multiple independent DVRs or Camcorders?

There are reasons why using several independent DVRs or camcorders may make both the production and post-production workflow inefficient, difficult, and costly:

- 1. Inability of the videographer to monitor and assess each video source in one screen during the shoot in one central location, particularly when using one or more ISO cameras.
- 2. Difficulty in comparing each camera angles view for similar exposure, focus, and coverage.
- 3. Difficulty in reviewing the footage after each shot without stopping the production for playback.
- 4. No uniform way to ensure each scene, shot, and take numbers are the same on each camera shot.
- 5. Synchronizing the videos after the shoot for editing.
- Media storage cards can fill up during lengthy shoots with multiple takes. Using DVRs/camcorders with multiple cards can leave a "gap" between recordings when the device automatically switches to the 2nd card while recording is occurring.

Organizing and synchronizing each of the video files from multiple media storage cards after the shoot can be a daunting task—particularly for the editor. Deciding which camera angle, scene, shot, and take number relates to the associated video file requires good labeling and ensuring each camera's file names can be deciphered. Once the footage has been identified, the editor must import and organize the video files into the NLE bins for access. The files must be then synchronized to each other for each shot. The difficulty increases if there is no time code or precise time stamp. It may be necessary to rely on a simultaneous audio handclap picked up by each camera or a visual slate closing visible to all of the cameras.



Figure 2. Typical multi-camera workflow using multiple DVRs/camcorders is inefficient.

There are several instances when it is preferable to have separate DVRs/camcorders. In an uncontrolled or harsh environment, where setup and cabling has to be done quickly or the distances involved between camera positions are long, it's preferable to have independent operation of each recording device, rather than being cabled to a single recording device. Of course, this is also true of live production systems (even with wireless). Although some systems (e.g., V-Station HD), can use low-cost HDMI wireless, the more expensive SDI wireless systems can cost more than a single camera or DVR. Also, using more than two such wireless systems at the same time can cause interference problems,

especially if the distances are too long or there are moving objects between the transmitters and receivers.

What types of video production are suitable for multi-channel video recording systems?

Many types of event videography, such as theatrical performances, musical events, religious services, lecture/meeting capture, community television programs, internet video productions, corporate communications, training videos, and interviews are good candidates for multi-channel video recording. Certain sports training can also be done, as long the shoot can be rigged so as to not interfere with the event. There are also uses in scientific/clinical applications wherein the environment is well controlled and the objective is analysis and annotation of the footage.

Typical User Scenario

A two-person videography team shoots concert with 2 stationary ISO cameras, one on stage shooting toward audience and one at back of venue with wide shot of entire stage. They use cameras 3 and 4 for closeups and to follow the lead singer's movements. After wrapping, the concert is replayed and the edit decisions are made, a rough-cut reel is created and uploaded to a secure ftp site for the performers and producer to review. The V-Station HD project is transferred to the videographers' non-linear editing system to create a polished version that is ready for exhibition.

In contrast, video production scenarios where it's better to

use independent DVRs and camcorders usually involve difficult environments and spontaneous camera tracking such as documentaries, commercials, and sports activities. These shoots are difficult because locations are fluid, camera distances can be long, and the environment may be inhospitable for running cables to a central unit. Wedding videography, depending on the venue, may be easier to use camcorders, but in certain cases the combination of 2 wireless and 2 wired cameras with a multi-channel DVR may also work well.

Since most cinema/film production is done using a single camera (or least one angle at a time), it is generally not a suitable candidate, unless multiple angles need to be shot simultaneously (e.g., an effects shot) or is used for pre-visualization. There are also strict union rules that govern film set activities. On-set editing, as one would do in multi-camera video production, would be an option only on indie non-union productions. Equipment costs may be less if only camcorders are used, but the workflow efficiency will suffer and the hidden costs increase.

Post-production workflow advantages using multi-channel video recorders

There are several post-production workflow advantages in using multi-channel recording:

- 1. Since all recordings are on one disc drive, it's difficult to misplace footage and easier find the shots taken from all of the video cameras.
- 2. As some multi-channel video recording systems (e.g., V-Station HD) keep track of each reel, scene, shot, and take number for all cameras within its file and folder structures, locating the associated clips for the project is efficient.
- 3. Backup of a hard drive is much faster and easier than using individual media.

- 4. The recordings can be easily synchronized so that when transferring to the NLE, there is no difficulty in aligning the shots.
- 5. Using a compatible recording format on all channels, there is no incompatibility between the recordings (i.e., resolution, frame rate, encoding) that would otherwise require transcoding of the video before editing can begin.
- 6. The ability to record longer than the standard 2GB file size used in AVCHD camcorders eliminates unwanted segmentation so the entire event can be shot irrespective of file size and event duration.

Migration from production to post-production can be laborious. FutureVideo's V-Station HD system incorporates a XML project transfer capability. Using XML for project definition and generating this file while exporting the project simplifies the process. In the case of V-Station HD, XML files are created that are compatible with NLEs such as Adobe Premiere Pro, Apple Final Cut, and Sony Vegas Pro. Importing a project in this way creates all the bins and generates all the sequences (from EDLs) that were created during or after the shoot. This makes the workflow much friendlier for the editor and saves a substantial amount of time.



Figure 3. XML Project Transfer automatically generates bins and sequences from V-Station HD.

Multi-channel recording is also advantageous due to the simplicity by which the backup can be made during or immediately after the shoot. This safeguards the camera footage in case there is a later failure of the hard drive. Some systems, (e.g., V-Station HD Studio4) systems have redundant recording using a Raid 1 mirroring during the shoot as an extra safety measure.

With such systems, it's possible to use one or more ISO cameras in a multi-channel shoot. This way only 1 or 2 camera operators are necessary to get the primary shots, helping contain costs.

The significant reduction in post-production time shooting with a multi-channel recording system means more productions can be completed in less time. For the videographer or editor laden with projects, this

is an important benefit. Taken together, there is a meaningful cost benefit (time/staff) necessary for multi-camera video production with a multi-channel video recording system.

What are some of the features found in multi-channel recording systems?

Live Monitoring/Logging/Live Switching/Edit Decision Lists

Multi-channel systems allow monitoring all the inputs in one screen so each angle view can be seen simultaneously during the shoot. Some systems offer the ability to switch between angles live (i.e., line-cuts) and either output this feed for broadcasting/streaming live or use it to create edit decision lists (EDLs) that can be used on-set to make a rough-cuts of the shoot (e.g., V-Station HD). Also, marking or

tagging the video angle(s) at any time during the shoot can be done in some systems. This ability to make notes while recording can be preserved with the video clip as metadata and minimizes the need to keep hand written notes.

Playback, Off-line Editing, and Collaboration

Some multi-channel recording systems provide the means to playback one or all camera angles immediately after the shoot on the same recording system. Some systems offer a special media player for play back of the recorded videos on a secondary or third screen (such as a studio monitor and/or projector screen for the audience). One system even provides a synchronized quad view play back of all the video angles recorded on one screen, thus re-creating the shoot (FutureVideo's V-Station HD Multi-View® Player). In this case, it allows the director or client to have an immediate review of all camera angles together. During the review, some multi-channel recording systems allow making notes at any frame, so later during post the editor can see the comments. Since it is not necessary to wait to transfer the footage and EDLs to the NLE system, FutureVideo's V-Station Pro4 Plus and Studio4 also creates a rough-cut video track of the "takes" made during the shoot. These rough-cuts can then be uploaded to YouTube or other video FTP sites for collaboration with others between scenes/shots or at the end of the shoot.

Multi-channel recording formats and Input/Output signal types

Other Types of Multi-Channel Recording Systems

Multi-channel Security or CCTV recorders are not suitable for video production. Their design places them in a different product category. The reasons are several. Video file formats are proprietary and not easily decipherable or alterable. The video is frequently multiplexed with the other videos, so there is no separate video file for each channel. The resolution of such recorded video is typically below what would be expected for video production. User interfaces are configured for security rather than video production. There is no efficient means to move the video footage and metadata to post-production systems.

Multi-channel ingest systems have been used to record multiple video feeds—which are not necessarily multiple camera angles—but can be from completely different sources. The software is designed for the broadcast television market, or may be used for archiving/media asset management of television programs.

Multi-channel recording systems depend on the particular

capture card used and codecs incorporated in them. There are a variety of formats for input and output that can be used. Currently, 2K formats are more affordable and readily available for 4 channel simultaneous recording. As with camcorders, MPEG-4/H.264, AVCHD, DV/DVCAM, DVCPRO, MJPEG,

ProRes, and uncompressed raw recording may be supported. Wrappers can be AVI, MPG, MP4, MOV, or WMV. With H.264 hardware encoding, it is possible in some multi-channel systems to be able to record up to 160 hours of simultaneous 4 channel Full HD (1080p60) on a single 2 TB drive (e.g., V-Station HD).

Multi-channel recording systems have either HDMI or HD-SDI (BNC or mini-BNC and mini "F") video connectors. While most professional cameras offer SDI output, many suitable camcorders and DSLRs have a HDMI output. Both types are available depending on the system or can be converted from one to the other using low-cost converters. This gives the user flexibility in camera decisions.

Typical audio support includes the 2 embedded channels for each HDMI or SDI input, 3.5mm (1/8") analog line or mic inputs, some with XLR audio inputs. Some systems also include 2-channel auxiliary inputs and support a USB Audio Interface for using an audio mixer with a digital 2 channel sound track and up to 4 auxiliary channels that can be embedded into the video in place of the camera's own audio (e.g., V-Station HD).

Project/Media Asset Management, and Project Transfer

When recording many channels of video, whether it be for multiple sessions, or starting and stopping for each scene, shot, and take in a single session, the number of video clips can be difficult to manage without a method for project and media management. Most systems provide some form of project management and others (e.g., V-Station HD), provide a full media management SQL database feature to manage all the assets and metadata for each project's recordings. This makes it easy to go back later and either record more clips for the project, or select clips from previous projects and output them to a sharing site or an NLE. This facilitates efficient project transfer. Backup of the project is important and the ease of backup or replacement of the HDD (using a swappable drive) is a key factor.

What products are currently available?

USA-based FutureVideo pioneered multi-channel video production recording systems for Event Videography. These were described as "Multi-track DVRs" to associate the analogy of multi-track audio recording with video. These are "production" DVRs which differentiate them from Security/CCTV recording systems. The company currently offers turn-key DVR systems with various features, capabilities, and price levels. For example, the V-Station HD Pro4 DVR provides a lightweight and portable 4 channel DVR for field shoots at a very affordable price (starting at \$2995), while the V-Station HD Studio4 (starting at \$5995) is a rack-mount, 4 channel DVR which has numerous configuration and post-production options for in-house studio use. The Pro4 and Studio4 series DVRs also have the ability to do live switching, record simultaneously 4 live channels into synchronized video tracks, and in addition, both the Pro4 Plus (starting at \$3995) and Studio4 record the switched output ("takes") as a 5th video track. These systems have either HDMI or SDI inputs and the HDMI outputs, and record in full HD at 1080p60 with 8 channels of embedded audio, and 2-4 channels of analog or digital audio via an optional USB audio interface. They record either an MPEG-2 TS, AVI, or MP4 video file, using H.264 hardware compression and can record up to 640 hours of continuous full HD video (or 160 hours for all 4 channels simultaneously). The MPEG-2 TS video recording is fault-tolerant, so in the event of a power failure, the recording is not lost. All systems incorporate a full SQL database management system for

keeping track of all the projects, media assets, and metadata. V-Station HD systems have an exclusive AutoProducer[®] feature for performing line-cuts while recording and creates an EDL that can be quickly made into a rough-cut after a scene or set. The also have a fully featured media player to play back the video either on a touch screen monitor, desktop PC monitor, studio monitor, or projector screen. The Multi-View[®] player add-on for Studio4 allows synchronized play back of the session. In addition, all the systems have a XML project transfer feature to the NLE, which is a major time saver for the editor. It will create the bins and sequences automatically for the editor without the need for syncing or transcoding.

Canada's Matrox offers the VS4Recorder Pro bundle for a build your own system (MSRP \$2,495). This solution comprises its VS4 capture card combined with their VS4 ProRecorder software. It also runs on the Windows platform. The user has to provide a compatible PC to realize the benefits of the system. The capture card has 4 HD-SDI inputs and uses software compression to record 4 channels of HD video and 8 channels of embedded audio. It supports MPEG-2, H.264, ProRes, and other DVCPRO/DVCAM formats. It supports recording resolutions up to 1080i60 or 1080p30. The files can automatically be split into segments as it records. This feature allows editing the segments while it continues to record. The software does not offer any play back features. Since the VS4 card is also compatible with 3rd party software (e.g., Telestream Wirecast) it supports live video production and streaming when used with this software.

Belgium-based Softron Media Services offers the M| Family (starting at \in 8,495) of thunderbolt connected multi-channel recording units for Mac users. It comes with their MovieRecorder software and uses the Deltacast capture card. It supports MXF, Quicktime, and H.264 recording formats. Editing is possible while ingesting and it has a scheduler for setting start and stop times. It has looped recording and can support up to 8 simultaneous sources. These systems require the user to provide the Mac computer. They integrate well into Apple Final Cut Pro editing software.

Summary

Multi-channel video recording systems offer the videographer and small production company new opportunities for a variety of multi-cam, multi-angle video productions. Some productions will still lend themselves to using independent camcorders/DVRs. As the systems discussed here vary as to the capabilities and features, choosing the correct one for the best needs of the videographer is important. Whether used for event recording, A/V communications, or scientific/clinical applications, we'll see more and more such systems come to market in the future. UltraHD (4K) cards capable of simultaneous multi-channel recording are starting to emerge and systems using them will soon be offered.

Cinema/film producers will continue to use single camera recording due to the unique nature of their work environment, as will those involved with video production in uncontrolled environments, where cameras have re-positioned quickly and cables are a liability.

Independent videographers, small production companies, community television stations, houses of worship, educational institutions, and corporations who do training derive many advantages from multichannel recording due to the time savings afforded them. This provides the opportunity to complete more projects in less time. Independent videographers and small production companies can expect to use fewer people and increase their revenue stream.

Further information about the multi-channel recording systems for multi-angle applications:

www.futurevideo.tv

www.matrox.com

www.softronmedia.com

About the Author

Robert A. Cohen is the CEO/President of FutureVideo Products, Inc. As a systems and electrical engineer, he has been involved with all phases of product development, including hardware design, circuit design, and software design/programming. He developed and programmed one of the first relational database systems for microcomputers in the mid '70s (Condor DBMS), and holds many patents and awards for products he has designed. Mr. Cohen has also worked in the defense industry and the Hollywood audio recording industry. He co-founded FutureVideo to bring affordable video editing solutions to prosumer and industrial video users. He resides in Laguna Niguel, California.