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BROADCAST ENGINEERING®

September 1996
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features

columns

departments

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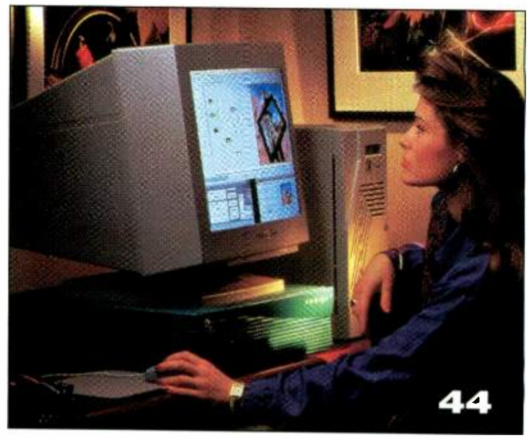

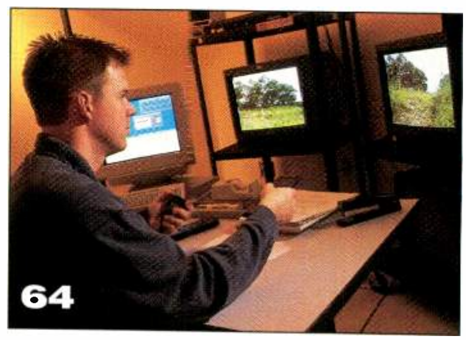

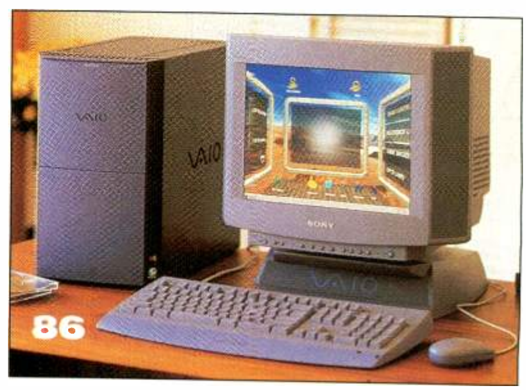

ON THE COVER: The Solid State Logic Scenaria with ScreenSound at USA Networks in Jersey City, NJ, is used to edit and mix special projects as diverse as the adult cartoon series *Duckman*, promotional material and player profiles for the U.S. Open Tennis Tournament, the documentary series *Inside Space*, and a behind-the-scenes program for the hit movie *Independence Day* on the SciFi Channel.

editorial

Frankenstein TV

As I began to write this column, I called up the standard file name for the September Editorial. Up popped last year's Editorial for September. As I read the wonderfully written copy (after all, I did write it), it was deja vu. One year ago this month, the column discussed the vice president of Apple Computer's Advanced Technology Group, Dr. Donald A. Norman, trashing the Grand Alliance proposed ATV system. Calling it an *anchor around our necks,* Norman presented his view of how American consumers would use their living room TVs.

It was video nirvana. Children doing their homework on the family's "Theater Vision home theater."

The family gathers around as the daughter voluntarily switches from watching a rock concert to researching her paper on the Mona Lisa. Using the WWW the family tours the Louve Museum in Paris, then moves on to the Gates Da Vinci art collection.

Hockey puck and up chuck! That ain't gonna happen. In the last year, we haven't moved an inch. The computer industry still wants the FCC to throw the baby out with the bath and not approve the GA standard. They are still claiming that there is a world waiting to do E-mail, surf the Internet, shop and bank and a whole list of other dumb things on their TV/PC screens.

Well, in case you haven't been listening Mr. Norman, you were wrong then and you (and your industry) are wrong now. *BE* just happens to have some of the smartest and most savvy writers in the industry and they, along with a large contingent of broadcast, cable and communications engineers don't see the TV as the next wave of personal communication devices.

Writer and industry guru Marjorie Costello has reported numerous times on the computer industry's attempt to reinvent the wheel with PC/TVs or TV/PCs, whichever you want to call it. Insiders Mark Dillon and Steven Blumenfeld from GTE Entertainment, who just happen to be on the leading edge of interactive TV, thank you very much, have also covered this issue. If you think these two guys support the computer industry's approach, just read their column this month. They're not sitting on the sidelines — they are part of the computer industry!

You can cram the Internet into the TV. You can add a CD-ROM. You can even add memory, remote control and include a wireless keyboard. When you're done, you've created the proverbial Frankenstein TV — lots of parts wired together in an attempt to create something useful. What you've really got is a useless feature-laden, overly complex, expensive monster.

I know Thomson's Joe Clayton really wants you to buy a new TV set, but you can't make people use a device that is neither convenient to use or cost-effective. All those additions to TV sets is akin to adding a set of cow horns to your car. It doesn't improve the looks and it certainly doesn't add anything to its performance.

Go honk that Mr. Norman.

Brad Dick

Brad Dick, editor

Editor's note: Got a thought on where the TV vs. PC revolution should go? Write me. The best letter gets a free *BE* T-shirt.

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letters to the editor

July's "Production" column on handling multichannel audio

Dear editor:

You talked about surround sound for an entire page without providing much useful information. I was dying to know:

1. What is the matrix for encoding and decoding surround sound?

2. How do you encode four channels into two channels so they can be recovered? Saying "backward-compatible 4-2-4 matrix" with "sum-and-difference quadrature techniques" leaves me with no understanding. For example, how can quadrature be used to identify information in the mass of frequencies and amplitudes found in program audio?

3. What kinds of audio processing destroy surround sound and why? Independent limiting and compression? Phase scrambling? Aural exciters, such as Aphex? What should the CE know about passing network surround sound?

4. Did you know ABC TV told affiliates last summer to disable all phase-shifting equipment before Monday Night Football began, so as not to destroy surround sound? Why did they do that?

5. What are "multiple coincident pairs," "S-levels in M-S mic setups" and "dipole speakers?" What percentage of your readers do you think could define these terms?

Why don't you concentrate on useful and basic concepts that we can apply to our work?

Dave Moore, CE
KHON-TV
Honolulu, HI

Terry replies:

A one-page article on surround sound is like a one-page article on do-it-yourself brain surgery — pretty dangerous. This article attempted to provide an overview to start you off on your research. In addition, when writing any article, a decision has to be made as to how far back into basics to go.

Unfortunately, your questions 1, 2 and 5 are beyond the scope of this article and the responses would be lengthy. To briefly answer 3 and 4: Any broadcast/production facility, storage medium or processing equipment that modifies phase, polarity or frequency response from the original will affect stereo imaging mono-compatibility and proper surround-sound decoding. Phase and polarity are especially critical.

I suggest that stations use no AGC equipment, especially multiband processors, no automatic phase or polarity "fixers," and definitely no "stereo synthesizers." The audio carnage filling many of our TV channels illustrates what happens when this advice is ignored.

For further information, refer to numerous Audio Engineering Society papers on surround sound and books on stereo microphone techniques.

Regards,
Terry Skelton

July's "Digital Basics" column on new compression chips

Dear Paul:

Your article on "New Compression Chips" made interesting reading.

However, I have a couple of comments worth sharing. First, the wavelet transform has a lot of advantages over the much used (or abused) DCT, specially at low bit rates. Notably, the lack of the "blocking artifact problem." However, I do not think that the wavelet transform provides superior quality over DCT at higher bit rates. Therefore, it is not fair to compare the two transforms in a generic sense. Instead, they should be compared in an application/functionality context. For example, I may have a compression application where scalability may be a non-issue. Hence, I may opt for DCT.

Second, the MPEG committee has not turned a blind eye toward the wavelet transform. In fact, it is a key component in MPEG-4 and addresses a major functionality of scalability. In the future, you can expect MPEG codecs implementing the Wavelet Tx, but my guess is that these codecs would be applied in applications where scalability is a major issue, as opposed to quality.

Cheers.
Arun Ramaswamy, Ph.D
Vela Research Inc.
St. Petersburg, FL

Paul replies:

I agree with you that applications must be compared before deciding on the best technology; also scalability is a key for future work and in that wavelets win

Continued on page 97

news

By Dawn Hightower, senior associate editor

Asia Broadcast Centre signs deal with PanAmSat

Asia Broadcast Centre in Singapore has signed a 10-year, multimillion dollar contract with PanAmSat to provide a full-time, digital compression platform system and other services.

The center is using a Scientific-Atlanta MCPC PowerVu system. The multiple channel per carrier compression system will handle traffic on the PanAmSat-4 (PAS-4) satellite.

The center also will serve as a backup location for PanAmSat's tracking, telemetry and control hardware and carrier monitoring system used to track the PAS-4.

The deal is significant for Asia Broadcast Centre, because it is the only independent broadcast distributor granted a carrier class license for satellite uplink from the Telecommunications Authority of Singapore. It also represents the first agreement with a major satellite provider in the Asia-Pacific region.

SCTE enters the digital video arena

The Society of Cable Telecommunications Engineers (SCTE) is venturing into digital video technology by forming the Digital Video Subcommittee. This group has issued a call for participants, as well as a call for proposals for digital video standards and practices it will develop for submission to the American National Standards Institute (ANSI).

The subcommittee is responsible for developing the standards necessary for delivery of digital TV services via cable and aims to complete its work by the end of the year. To achieve this, the subcommittee has established the following working groups: video and audio services, data and transport applications, network architecture and management, transmission and distribution and encryption and access control. Submissions can be sent to Paul Hearty, General Instrument Corporation, 6262 Lusk Blvd., San Diego, CA 92121. For more information, contact Hearty at (619) 623-2935 or fax at (619) 535-2485; or contact SCTE director of standards Ted Woo at (610) 363-6888.

FCC approves Datacast's Digideck system

The FCC has given its approval of the Digideck system from Datacast LLC. The system inserts high-speed digital data into conventional TV station signals. The FCC's action clears the way for Datacast to continue its development and deployment of a national data network for delivering multimedia products to computers. The Digideck technology is digital and transmits at speeds more than 700kb/s.

HDTV stations moving forward

WRAL-HD, Raleigh, NC, the first commercial station to broadcast HDTV, demonstrated the new technology to the industry and media on Aug. 6. The demo was a joint exhibit by WRAL-HD and the Model HDTV Station in Washington, DC, (WHD-TV), showing the first public on-air broadcast and reception of live and taped digital HDTV signals.

The first phase of the station's operation will test signal strength in the Raleigh-Durham-Fayetteville area. A regular fixed program schedule will begin this fall.

SBE plans for future

By Edward J. Miller, vice president of the Society of Broadcast Engineers

The Society of Broadcast Engineers evaluated its purpose in a day-long think tank and strategy planning session. The discussion focused on keeping the society beneficial to its members as demographics and technology change. Other issues discussed included re-defining the SBE's role and how the organization can best address membership concerns; the need for more effort toward establishing a good PR image in the workplace; more effort toward improving chapter communications and relations; possible expansion of the certification program to include the non-broadcast-related industry; and evaluation of membership dues to support future growth.

A "Futures" committee has been chosen and consists of Andy Butler, Jim Bernier, Marvin Born, Mike Fast, Tom Weber and is chaired by Edward Miller. The committee is charged with implementing the findings of the planning session.

The Satellite Communications Users Conference sports name change

After 18 years as the Satellite Communications Users Conference (SCUC), the show's organizers have introduced a subtle name change to ensure that the show continues to attract a comprehensive audience of satellite communications users and professionals.

SCUC is now SCEC, the Satellite Communications Expo & Conference. The exhibition is an important part of the total conference experience, and the name "Users Conference" missed that element. SCEC better communicates what the show has always been about — technology deployment for professionals who plan, buy and use satellite communications services, systems and products in worldwide markets.

SCEC '96 will be held Sept. 24-27 at the Sheraton Washington Hotel, Washington, DC. Call fax-on-demand at 1-800-601-3858 for a brochure. ■

By Robert D. Greenberg

FCC tower registration, part 2

In Part 1, highlights of the FCC's R&O on tower registration were outlined along with the who, what, when and where of registering your antenna structure.

Supplemental filing/posting requirements

In registering more than 75,000 antennas, many owners will likely initiate site surveys to ensure the validity of site information. With the proliferation of inexpensive satellite-based locating devices, such as Global Positioning System (GPS) receivers, some structures that may have been previously located using an area map can now be located to a higher degree of accuracy using "differential" GPS. Also, the antenna registration number must be displayed and be visible from the structure's base.

The commission will request location data in terms of degrees, minutes and seconds, and height data to the nearest meter. The database will accept latitude and longitude data in either the NAD 27 or NAD 83 datum, up to an accuracy of one second and height to one meter. Owners must specify which datum is used and may use surveying tools of differing accuracy, such as maps, GPS receivers or GPS receivers with differential corrections. It is left to each owner to evaluate the surveying method and round to the appropriate digit. Seven and one-half minute geological maps may yield accuracies within one second, GPS receivers may be accurate to ≈3.3 seconds, while GPS receivers using differential corrections may be accurate to ≈0.05 seconds.

The FCC will not issue forfeitures to owners or licensees attempting to correct site data during registration. Commission authorizations and FAA determinations of "no hazard" to air navigation, however, are based on the originally submitted data. Thus, changing the coordinates on tenant licensees' authorizations, depending on the magnitude of the error, may violate the interference protection criteria or may invalidate the original FAA determination.

Therefore, the FCC clarified the procedures by which owners and tenant licensees may ensure that correct data appear in the registration and licensing databases. Owners must submit accurate data without regard to the height or coordinates listed on licensees' station authorizations. Existing structures will be assigned painting and lighting specifications upon registration based on data from the original FAA determination for the structure or from data referenced in the current antenna clearance database. Corrections of previously submitted data of less than one second in latitude or longitude or of less than a foot in height, will not require a new aeronautical study, and the structure will retain the previously assigned painting and/or lighting specifications.

The FAA requires a new study for corrections in latitude or longitude of one second or more, or a correction in height of one foot or more. In this case, the owner must seek a new FAA determination prior to registration, and the structure will be assigned painting and/or lighting requirements based on the new determination. Each owner must provide a copy of the registration to all tenant licensees. Licensees should note any discrepancies in the data appearing on Form 854R and their station authorizations and notify the appropriate licensing branch. Tenant licensees will not be required to submit a filing fee when correcting site data. In cases where a correction of data for a tenant licensee would be in violation of the rules for a particular radio service, the licensee(s) involved may be required to take measures to avoid interference. In general, the FCC will not require tenant licensees to cease operations while the owner seeks a new FAA determination or while coordinating corrections with the individual FCC licensing branches.

Statutory considerations

Registering a structure constitutes a "federal action" under the National Environmental Policy Act of 1969 (NEPA) or "federal undertaking" under the National Historic Preservation Act (NHPA), such that the imposition of environmental responsibilities on the owner is justified. The owner may be proposing to register and construct a structure at a location that affects the environment within the context of NEPA. Irreparable harm to the environment may be avoided by requiring owners to assume responsibility for environmental compliance at the outset. Moreover, such a requirement will effectuate the implementation of federal environmental policies that require that environmental considerations be integrated into the planning stages of authorized actions. This is particularly true here because the location of an antenna structure in a sensitive area, as defined by Section 1.1307(a), will, in most situations, have the greatest effect on the environment. The subsequent application for an authorization on the structure is a federal action that may have little, if any, additional environmental consequences.

Furthermore, the FCC will divide the responsibility to comply with environmental rules between owners and tenant licensees. A distinction exists between environmental responsibilities pertaining to structural matters and responsibilities pertaining to radio frequency radiation (RFR) levels. Owners who file Form 854 must also comply with federal environmental rules pertaining to the site at the time of registration, while RFR levels at the site will be the responsibility of the tenant licensee(s).

For new structures, under the environmental rules, an owner will be required to identify whether the proposed site is in a sensitive location as defined in Section 1.1307. If so, the owner must prepare and file an Environmental Assessment, which must be reviewed by the FCC prior to registration and construction. In the event that the owner is unable to register the structure due to the ADA, the first authorized tenant licensee would be responsible for registering the structure and complying with NEPA pertaining to the site, as well as RFR levels, at the time of registration. Licensees authorized on structures not subject to registration would remain responsible for complying with the environmental rules.

Part 17 update

The FCC incorporated FAA Advisory Circulars "Obstruction Marking and Lighting" (AC 70/7460-IH), August 1991, as amended by Change 2, July 15, 1992, and "Specification for Obstruction Lighting Equipment" (AC 150/5345-43D), July 1988, in Part 17. This will not change the current procedure in which the FAA recommends painting and/or lighting specifications for a particular structure. The FCC will continue to use the FAA recommendation in meeting its statutory responsibility under Section 303(q) of the Communications Act to prescribe painting and/or lighting requirements.

Owners are not required to update painting and lighting requirements unless recommended by the FAA. The FAA recommends painting and lighting for towers prior to construction only. For existing structures, Form 854R will, in most cases, denote the specific painting and lighting requirements originally assigned. Owners may retain the original painting and lighting requirements indefinitely or may apply to paint and light in accordance with current recommendations. For new construction or alteration of existing structures, Form 854R will reference the FAA Advisory Circulars found in Part 17 at the time of registration.

Primary responsibility

Antenna structure owners will be responsible for maintaining painting and/or lighting in accordance with Part 17. The owner has the primary responsibility for maintaining the painting and lighting, while individual licensees have a secondary responsibility. The FCC rejected the view that licensees on the structure should be relieved of all responsibility for maintaining the prescribed painting and lighting. The reason is twofold. First, in enacting Public Law No. 102-538, 106 Stat. 3533 (making structure owners, as well as licensees responsible for the painting and lighting and making non-licensee structure owners subject to forfeitures), Congress did not suggest that licensees should be relieved of their responsibility to maintain the structure painting and/or lighting. Second, one of the FCC's primary responsibilities in this area is ensuring that antenna structures do not pose a threat to air safety. For public safety reasons, the FCC must have means to ensure that painting and/or lighting is maintained at all times and that lighting outages will be promptly rectified. Continuing to impose a responsibility on licensees will make it incumbent on them to assure that the owner maintains painting and/or lighting, and, if necessary, take steps to maintain painting and/or lighting in the event of default by the owner.

Under normal circumstances, the FCC will only look to the structure owner to maintain the painting and/or lighting. However, in the event the owner is unable to maintain the painting or lighting, *e.g.*, in cases including but not limited to abandonment, negligence or bankruptcy, the commission would require that individual licensees undertake efforts to maintain painting and lighting. Additionally, if a tenant licensee has reason to believe that the structure is not in compliance or that the owner is not carrying out its responsibility to maintain the structure, the licensee must immediately notify the owner, notify the site management company (if applicable), notify the commission and make an effort to ensure that the antenna is brought into compliance.

The FCC is not requiring licensees to independently monitor the antenna. Instead, licensees must assume responsibility and take appropriate action if circumstances would lead a reasonable person to question whether the structure is being maintained. Under these circumstances, any sanction that may be directed to a licensee will be determined on a case-by-case basis depending upon the magnitude of non-compliance, its length of time, access of the licensee to the structure and the diligence of the licensee to rectify the non-compliance with the prescribed painting or lighting or to alert the FCC or the FAA. ■

Robert D. Greenberg is a senior supervisory engineer with the Federal Communications Commission, Washington, D.C.

Serving the public interest

The actions in this proceeding will serve the public interest by: 1) expediting application and notification processing; 2) streamlining regulations to ease the public and governmental burdens associated with processing certain applications; 3) unifying federal regulations regarding antenna painting and lighting; 4) increasing safety of air navigation; 5) establishing that primary responsibility for antenna operation and maintenance rests with the owner; and 6) saving the industry and the commission millions of dollars each year. ■

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Circle (6) on Action Card

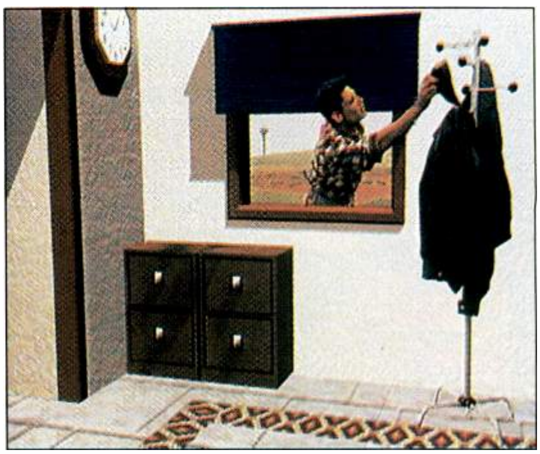
By Kenneth Hunold

Sets: Real and unreal

In television, the set forms the stage and backdrop where the talent performs. In keeping with the basic illusion of television, sets create the illusion that the actors are performing in a real house, street, meadow or wherever.

The art of set design

Set design is clearly an art, but it is also an art that requires a good deal of science in order to be convincing. For more than 100 years, the film industry has made images using a mixture of real and virtual elements. What we in television are now calling "virtual elements" the movie industry has called "effects." Primarily, these effects would be shot using mechanical and optical processes. This includes matte boxes to simulate large cities or landscapes and even moving backgrounds to simulate motion. The dramatic increase in the capability of computers, desktop and larger, has enabled a new branch of set design to develop sets where no wood, canvas or paint is used.



Virtual sets allow set designers to create imaginary worlds or to simply recreate the real world without the expense of set materials. (Photo courtesy of RT-Set.)

Television is primarily an electronic medium, so in order to accomplish effects similar to those in films, an electronic process needs to be developed. (For the moment, we will ignore the fact that TV shows are often shot on film, and that even in film, some of the effects are created by electronic means.) A phrase that has been borrowed from the popular computer game culture, and has become almost an instant buzz word, is virtual reality. Lately it seems, placing the adjective "virtual" in front of any common term creates an immediate buzz word. So it is with sets.

Virtual sets

Virtual sets, or at least the newest version of them, have appeared at NAB for the past two years. However, if you look back in time, elements of virtual sets have existed in television for many years. An early example of electronic virtual sets that survives to this day is the chroma-key. Announcers are placed against either a green or blue wall (depending on what color the talent is not wearing). Electronically, the color of the wall is detected and used to generate a key signal that is used to switch the video to another source. In this case, the background could be another live camera shooting a wide shot of the stadium. This would give the illusion that the announcers are standing in the crowd when in reality (pun intended) they are in front of a colored wall.

Although this illusion conveys the excitement of the announcers being in the stadium, it does not present an accurate simulation of reality. If the foreground camera moves to frame one announcer instead of two, the background does not move to follow the foreground image. Aside from the early newsroom style of chroma-key (where the effect is used to show the talent and some other graphic or video, but not to suggest that the talent was at the scene of the video), there were early studio uses of chroma-key virtual reality. Chroma-key blue (or green), as the paint colors came to be known, were used as part of the set, forming a frame into which a picture of someone could be inserted. This would give the illusion that there were two people in the studio, with the talent interacting with a person in the chroma-key frame as if that person was actually in the studio with the host.

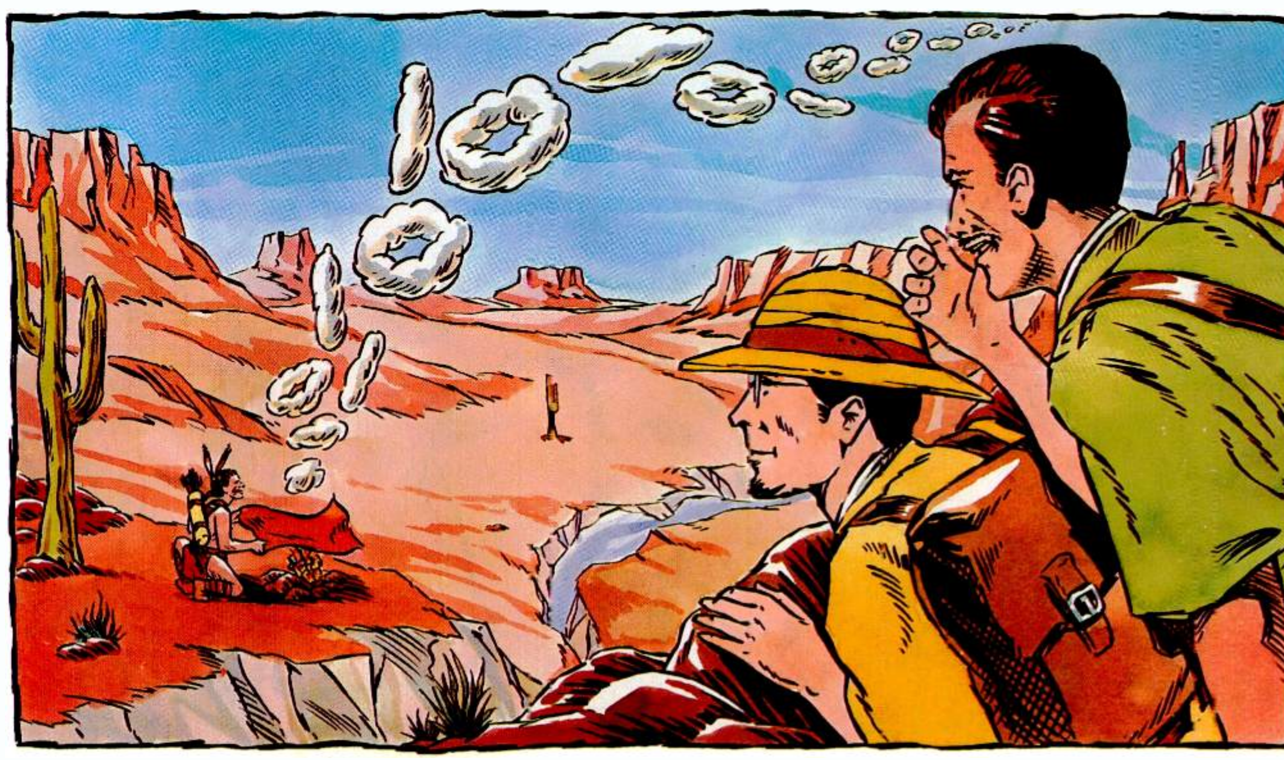
The basic concept of chroma-key — the ability to detect when the camera is shooting a color of a particular hue and saturation — remains a key factor in the modern virtual sets of today. An early implementation of the virtual studio concept (as opposed to the virtual set concept) was where a pair of motorized pan heads were slaved together, with one head mimicking the movement of the other. One camera shoots the foreground scene while the other camera shoots the scene that is intended to be the background. Any movement of the foreground camera is mirrored by the camera shooting the background, including pan and tilt, as well as lens zoom and iris setting (for realistic depth-of-field changes). Again using chroma-key, the colored background of the foreground camera is replaced by the video of the background camera. Because the foreground and background video is scanned by the camera and not created (or rendered) by an expensive computer system, this can be a cost-effective solution that does not require a lot of computing horsepower.

The next step would be to have the background stored in a still-store/DVE device containing a high-resolution version of the background image (perhaps either a high-resolution scanned photo image or an HDTV-resolution image). The DVE would track the foreground camera movement and simulate the necessary perspective changes.

A lot of the heavy-duty number-crunching must be performed on this virtual set. What results is a computer rendering of each frame of video in which the set appears. This rendering must be done from a mathematical model (which is the set) and must be constantly updated to reflect the perspective and the position of the viewer (i.e., the camera). In a traditional situation with a camera and a physical set, the perspective changes occur naturally through the optics of the camera. Because the image of the set is no longer coming through the camera optics, all of the perspective changes must be calculated.

To calculate the perspective, the image-rendering computer must have data input representing the position, motion and optical parameters (lens settings, such as zoom angle, focus distance and iris opening). This data is generated in many ways. On most lenses, all of the lens information is available through electronic servo readouts. For camera orientation some systems use position sensors on the pan/tilt head, others use motors that are commanded by remote control, while still others derive positional information from the camera video. The last method, using the camera video to derive positional information, allows the system to work with hand-held cameras. This adds another production element that can be used with virtual sets, and also requires the monochromatic backdrop that the moving foreground camera is shooting to have a recognizable pattern. This pattern must contain enough information to allow the computer system to derive its required data, but must not disturb the key or mask-generating function of the system. In other words, it must not spoil the chroma-key.

This brings us back to one of the tools that created the first virtual set effect and is still used to bring the real, physical elements together with the electronic elements — the chroma-key. The chroma-keyer generates a mask or key signal that distinguishes the real elements in the scene, and is used by the compositing device to piece together the final product. Many different types



"LOOK WILCOX, THE DIGITAL COMMUNICATIONS TREND IS CATCHING ON EVERYWHERE," WHISPERED SNELL.

of processes, such as opacity and layer priorities, can be applied to the key signal to give the resulting image its final look.

Electronic images

An application that can also use virtual set technology is one where the image to be displayed is already electronic data. This would include sports scores, election results, weather data, etc. This data could be animated in the traditional way or it could be reformatted with an eye toward how it would look if it were an interactive part of the set. The foundation for such new-age set design software would be in traditional animation software. Broadcasters are most familiar with these processes through their experience with DVE and character generator/electronic paint systems. Object moves, keyframes and effects time lines must be created for many elements in the virtual set.

Another application of virtual set technology, but one that relies primarily on image recognition, is the process of creating an object that appears on the TV screen, but not in the physical scene that the camera is shooting. Obvious uses for this technology could be the generation of advertising signs in the background of a baseball game or placing one of those ever-present channel logos on top of a football field or tennis court. In addition to the possibilities of extra ad revenues, with a system of this type it is possible to hang signs where they could not be placed before. There are some venues and sports that would prohibit the actual, physical placement of these signs This could be due to either contractual obligations or because they would upset or distract play, particularly in tennis.

From a production point-of-view, there are many reasons for trying electronic sets. It allows changes to be made in the set using electronic means. If the elements of the shot are separately recorded, changes can even be made after the live elements have been shot, with the new scene created by compositing the elements. The current crop of virtual set products appeared about two years ago, and were touting the projected cost savings in set construction. Considering that virtual sets must be designed in much the same manner as before (and the current cost of computer hardware and software), it is unlikely that virtual sets will actually cost less than physical sets.

Today's virtual sets require some of the same "construction" techniques as the sets they are attempting to replace. The first is the set itself. The set designer is still required, because the look and content of the set is even more critical. The function of the artist who formerly drew a sketch of the scene (the artist's rendering)

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becomes more important in the process. The artist's rendering, instead of being a guide for the construction of the set, actually becomes the set. All of the workmanship that went into the fabrication of the set must now be performed on this electronic version of the set, not the physical version of the set. The real value in virtual set technology is the added flexibility provided during and after the production. Using virtual sets shortens the time between "what if . . ." and the final realization.

The emergence of virtual sets will increase the complexity of TV productions incrementally, but will increase the creative flexibility of the process dramatically. It is an enabling technology that when done well opens up a world of possibilities in TV production. In the future, the virtual electronic set could be viewed as one of the pivotal developments in TV production, alongside the zoom lens, videotape recorder and digital video effects (DVE).

Kenneth Hunold is an audio/video project engineer for the ABC Engineering Laboratory, New York, NY.

Choosing virtual set technology

By Chris Young

Virtual set systems require sophisticated hardware. At the center is a powerful computer system capable of manipulating large numbers of 3-D objects in real time. High-quality digital cameras mounted on heads provide feedback to the computers. The cameras may even be computer-controlled. In addition, zoom/focus servos and pedestals may provide feedback and be under computer control. A blue (or green) set along with a range of props are needed to give talent the ability to interact with the virtual scene in a believable fashion. High-quality keyers and switching equipment are needed to put all the pieces together. Making a virtual set work effectively requires seamlessly integrated equipment and a team of artists, operators and on-screen talent that can transform ideas into (virtual) reality.

Personnel considerations

When choosing a virtual set system, make sure the systems under consideration provide your artists with a familiar 3-D design environment. It should provide the flexibility to design a scene quickly and easily that is optimized for real-time rendering. More complicated scenes can be pre-rendered, but that requires predefined camera motion paths, which limit the creative freedom of your production team. Choose a system that allows you to balance the need for artistic freedom during the preproduction phase and creative freedom for your production team during production.

Working with virtual sets doesn't have to change the way the production team works. It is beneficial to have the final composited scene appear in the camera's viewfinder. Even better is the ability to have composited views of all the cameras for the director. However, to achieve this requires a system capable of rendering scenes from different camera viewpoints. These capabilities become even more important if virtual 3-D objects are brought into the scene that must be tracked manually by camera operators.

Talent must also deal with changes in their environment. The image processing time can be significant and may be noticeable in the on-set monitors. Because of the video processing delay, audio delays will be needed, adding another level of complexity. At present, delays are an unavoidable necessity that buyers should be aware of. Minimizing these effects will make it easier for the talent to concentrate on their performance rather than the environment.

Validating the cost

It is no secret that the computing power behind a virtual set is complicated and expensive, especially when redundancy and fault tolerance are critical. One way or another, the cost of the system has to be overcome by the amount of revenue it can generate, either directly or indirectly.

Looking first at the tangibles, the single highest cost is for the system's real-time computing engines. Barring physical location restrictions, they do not have to remain dedicated to a studio that may only be in use a few hours a day. The computers can be used as general-purpose engines for the facility, spreading the cost over several departments. In a carefully designed facility, the system can be shared with the graphics pool's general computing resources during off-air periods. They can then be used for generic rendering jobs or to create promos, bumpers and news graphics.

For corporate clients, or those that rent out studio time, it is important to note that a single production studio can be switched over to a new setting almost immediately. This reduction of studio downtime can help a studio reach its maximum revenue-generating potential. When you consider that daily studio rates for a single pilot production for a virtual scene are between $12,000 and $15,000, the payback period can be rather short.

Moving to the intangibles, virtual reality can be used to give a unique look to a program that can become part of its brand image. Entertainment programming, special-events coverage, award shows, prime time news segments, game shows and children's programs are all candidates for this technology. Traditional set design has always played an important part of a program's image, and the same applies to virtual sets. ■

Chris Young is director of the Systems Group at Discreet Logic, Montreal, Quebec, Canada.

By Curtis Chan

Balancing technology burnout

Many years ago, Microsoft chairman Bill Gates predicted that business technology would eventually allow people to do a full day's work in a fraction of the time. They would be free to spend more time on leisure pursuits and with family and friends. That prediction hasn't materialized. In fact, people are working on average 42 hours a week as compared to 40 hours in 1982. What's more, being able to work at home, thanks to the home office boom, makes these numbers even more conservative.

In the past five years, more than 40% of companies have reduced administrative jobs. This has caused managers and employees to be engulfed by E-mail and other communications previously filtered by clerical support. According to Olsten Corporation, the main reasons cited were downsizing to cut costs, increased automation and change in the corporate culture. The reality is that people now perform more tasks in the same amount of time, which adds to job stress.

Making a difference in the moment

Many companies still rely on old management paradigms (paternalistic and domineering) for this decade's evolving technology revolution. The result of this type of management style in today's computer age is reminiscent of a Gestapo type of monitoring and controlling regime. If we think about how fast technology has increased our ability to analyze things to death, it is frightening.

Managers expect more tasks to be completed in the same amount of time, but often forget that technology itself has replaced layers of workers and the survivors now have more tasks to complete with less help. In fact, the term "multidisciplinarian" comes to mind if you read a want ad and compare it to one from 10 years ago. What's more, with E-mail, the Internet, fax machines, pagers, portable phones and laptops, the sense of urgency becomes paramount.

If we take the adage that work expands to the time allotted to it, we find that people abuse the power of technology. People using "technology" often find themselves doing things not because they should, or because they must, but because they can. Imagine the iterations and "what if" scenarios that you can do now on a computer vs. the slide rule days. Many people may also do this to look "busy" in front of their superiors or to feel that they are busy, but in fact, should be asking themselves if what they are doing is really benefiting the company. In other words, are you really making a positive contribution?

So for managers and employees, stop and smell the coffee or whatever suits your fancy and determine if what you're doing at the moment is really making a difference. You may feel busy, but are you being productive? As a manager, you should free up some time for yourself and your employees. Doing work for the sake of doing it leaves you with little time to be creative.

The other things to look out for are situations that can cause "brain fade" in your employees. In a recent survey from the American Management Association, the five most cited problems that caused stress were: 1) more tasks than time to do them; 2) too many meetings and correspondence; 3) dealing with incompetence in others; 4) poor communications from upper management and 5) inadequate acknowledgment of personal efforts. Technology can't rush a person's creative process without compromising the results.

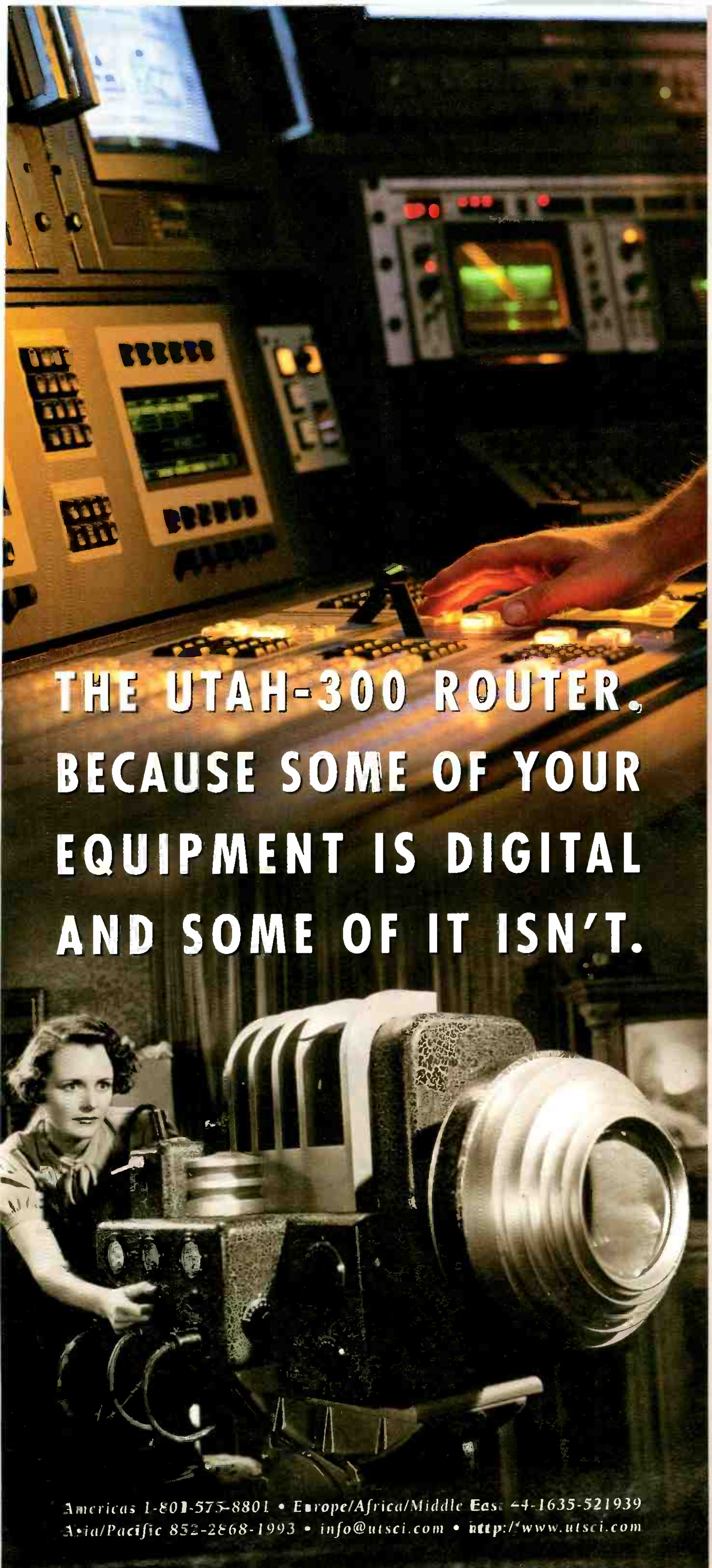
Technology for support

Another growing concern among managers is how to monitor an employee's workload away from the office. Thanks to the mobile office, the 40-hour week has long vanished. You must seek your own level of balance between workload and creative and relax time. This means coming to grips with your employer, friends, clients and your family as to when you can be approached. This also means that you need to understand that the technology is there to help you realize your goals and that it is a support mechanism and not a controlling agent.

So if your company has beepers, voice mail, fax machines, access to the Internet, portable phones and other "reach out and touch someone gadgets," give yourself and your staff a choice of how you and they want to be reached. This choice gives people the ability to better time manage themselves without being overwhelmed by technology.

The bottom line is that technology, like a tool, is a direct reflection of an organization's thinking and technology infrastructure. As a manager, learn to use the tool properly and you won't get hurt and can avoid technology burnout. ■

Curtis Chan is president of Chan & Associates, a marketing consulting service for audio, broadcast and post-production, Fullerton, CA.



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By Peter Bryenton

Lighting for video

Light is the stuff from which video images are made. When photons leap through a video camera's lens onto light-sensitive chips, electrons are sent rushing through the video signal chain. Ultimately, a copy of this original video waveform is re-created inside the TV monitor and electrons hurl themselves at the screen phosphors, forcing them to glow with light.

Quantity, *quality* and *direction* are three key words in lighting for video, which prompt the questions: "How much do we need?" "What should it look like?" and "Where should it appear to come from?"

• *Quantity:* The camera needs to be fed with light to make a broadcast-quality picture. (Typically, this could be 800lux from a tungsten source at 2,850°K for a lens aperture of f2.8 onto a neutral surface reflecting 60% of the light energy incident upon it, defining TV peak white.) Creating appropriate images takes more than mere illumination, however.

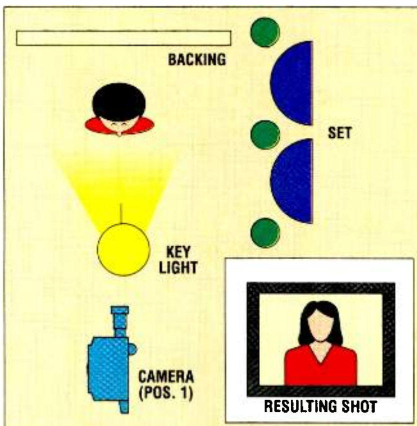

Figure 1. Presenter is lit and shot from the front, producing an acceptable result.

• *Quality:* The lighting team must paint with the right kind of light in much the same way that an artist might use different grades of pencil. *Hard* and *soft* light are two qualities of light that are poles apart. They can be used separately or mixed together.

In hard light, shadows tend to be dark in tone and have defined edges. Reflections and highlights are usually small and intense. Controlling hard light can be done easily using lenses, barn doors, flags, reflectors and a range of modern grip gear. Taken to extremes, hard light can have a rough feel, helping to create cruel, harsh or threatening looks.

Shadows from soft light are tonally lighter and have blurred edges. Highlights are often broad and diffuse. It goes all over the place if not contained, creeping around even large flags and cutters, giving a characteristic lift to an image, which reduces contrast and weakens color. Soft light seems smoother and can make more flattering, gentle or romantic images.

• *Direction:* Imagine that the talent is talking to the camera, introducing a short piece of videotape. (See Figure 1.) After seeing the tape, you wish to cut back to the same presenter, but want to change the camera position by crabbing left through 90° in order to reveal a different part of the studio. Such ways of maintaining viewing interest are commonplace and form the basic challenges that the lighting team must meet.

If the lighting setup stays unchanged, seen from the new point-of-view the talent will appear to be strongly side lit. (See Figure 2.) The relative positions of the subject, lighting source and viewpoint have changed — *direction* is the key word here. (In both figures, only main lights are shown for purposes of clarity.)

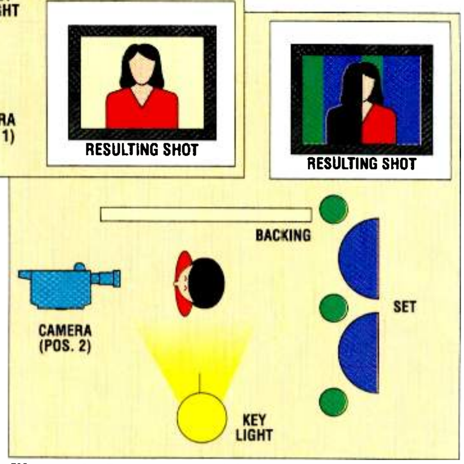

Figure 2. Camera position changes, but lighting doesn't, resulting in a poorly lit presenter.

For continuity of lighting style, a second lamp must be used. "Keep it simple" is a good rule-of-thumb. One lamp gives one shadow and two lamps will give at least two shadows. Living on earth, we are used to seeing faces with only one set of shadows. If we lived under the triple solar system of the planet Tharg, we might accept three nose shadows on a face. But here, we try to mimic an ordinary sunny day with our setups.

As initiator of picture quality, lighting professionals have responsibility for the technical and the artistic requirements of any production. They are, quite literally, the keepers of light. ■

Peter Bryenton is a lecturer at the BBC's Centre for Broadcast Skills

FOR MORE information

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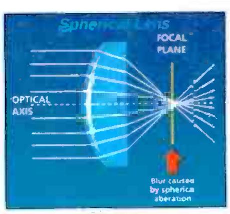

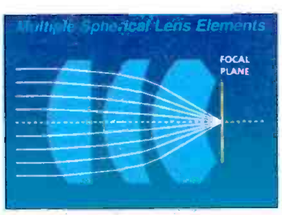

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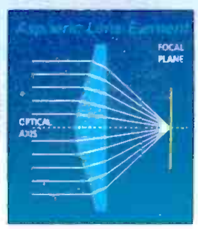

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Circle (15) on Action Card

By Steven Blumenfeld and Mark Dillon

Going on-line with your television

There was an interesting counterpoint to our column in the July issue of this magazine. In her article about the NAB, Marjorie Costello did an excellent job describing how the computer and consumer electronics industries are rushing to stuff the Internet into the home TV set. A few pages earlier, in this column, we made the subdued claim that "As long as more than one person is involved, interactivity in the TV room will be restricted mostly to decisions about which TV program to watch, not interactive shopping, banking or getting stock market quotes. VOD is no more interactive than VHS tape — just slicker."

So, what is the basis for these conflicting points? First, as TV monitors and computer monitors have become more similar technologically, computer TV set manufacturers have blurred their functionality and user environments. The result is primarily limited to connecting a CPU, CD-ROM and a modem to big tubes with big audio amplifiers. And as Gateway, Zenith, Thomson and others are showing, from an engineering perspective, it's easy (if not cheap). But because it *can* be done, *should* it be done?

The PC/TV

"Is it the PC/TV or is it the TV/PC?" — it's neither. A television is a display device. It easily allows anyone to turn it on, select a channel and watch. Televisions *will* get smarter — but when you go on-line with your TV set, conditions change radically.

Communications

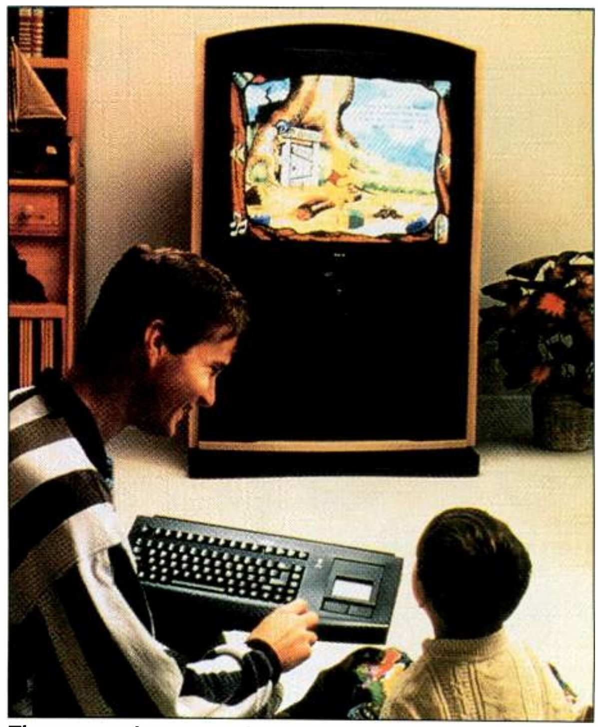
Conversations between individuals have been the killer app of the on-line services and the Internet. This can take the form of chat forums and E-mail. Whatever the mode, it requires a keyboard, some privacy and time.

While the keyboard can be designed, though a bit awkwardly, to work in the living room, privacy cannot be engineered. It is the nature of a television to be of a size and in a position to be easily viewed by as many people as possible. This is exactly the opposite conditions most of us want for E-mail and other personal communications.

Communication with another, whether real-time (chat) or time-displaced (E-mail), usually requires undisturbed time to write. Doing so *while* watching television can probably be learned, but doesn't seem natural to the TV viewing experience.

On the other hand, television has remarkable powers far in excess of a news group or chat room. The downing of TWA flight 800 and the Olympics were events that were shared as a community. They did so because of the tremendous information gathering, filtering and presentation resources of TV networks.

The idea of browsing the web on your television represents a culture clash between hardware manufacturers without much involvement from the software developers. From a hardware perspective, putting the web on television is easy. However, just because it is available doesn't mean people will use it. There is still a wide gap between personal communications and passive (or interactive) television. The bottom line is that "one size" does not fit all. There's a need for both types of display — and technology. ■



The personal computer is making the move into your living room, but how much interactivity do you really want from your television?

Steven Blumenfeld is vice president of technology and studio operations, and Mark Dillon is vice president, on-line services, with GTE, Carlsbad, CA.

By Louis Libin

Digital ATV: A brand-new RF system

All predictions are leaning toward the introduction of digital ATV as a gradual process from the consumer side, as well as the manufacturer side. Initially, the digital ATV market will be small, but as the new broadcasts begin, viewer interest and demand for the new receivers will increase. By the year 2002, the price of ATV receivers and set-top converters should bring ATV within reach of a mass market.

By late this year or early 1997, the entire FCC rulemaking proceeding should be concluded. The technology may be licensed to anyone on reasonable terms in accordance with FCC requirements.

The familiar analog system

NTSC is an analog signal. The picture information that we see is the modulated signal of the visual carrier, and the audio signal is the modulated signal of the audio carrier. The quality of the received NTSC picture deteriorates gradually with decreasing signal-to-noise ratio as distance from the transmitter increases. Because NTSC television is an amplitude-modulated system, the signals are subject to multipath "ghosts" and to natural and man-made electrical noise, which show up as annoying sparkles and lines in the picture.

Under normal conditions, analog transmissions provide excellent picture reception within the city contour nearest the transmitter; pictures of good, but not excellent quality, are received within the Grade A contour; pictures of marginally useful quality are received out to the Grade B contour. This is a gross oversimplification, of course. In the real world, TV reception varies widely from location to location and from time to time. The different grades of reception are statistically derived on the basis of time and location variability. Because of the shape and placement of the carriers, the 6MHz spectrum utilization is non-uniform. The signal power is concentrated at the visual carrier, while using only a small segment of the spectrum. In total, the remaining power of the signal is only 10% of the power in the visual carrier.

NTSC requires extremely low VSWR, approximately 1.05:1 at the visual carrier, especially at the antenna input. This is necessary to eliminate visible ghosts due to internal reflections in the transmission lines. The low visual carrier VSWR is also required because of the concentration of the signal at the visual carrier. In the rest of the channel, the VSWR does not need to be as low; 1.2:1 or lower is sufficient. Moreover, because the 6MHz channel is basically used in a uniform manner, the linearity of the phase and amplitude response over the 6MHz band is not critical.

The new digital service

The first-generation ATV field tests confirmed that digital ATV will outperform NTSC transmission. The digital ATV transmitted signal can deliver HDTV-quality pictures into the fringe areas of the existing NTSC contour, and do so with lower transmitter power and reliability.

In simplistic terms, the digital ATV signal is a string of digital pulse amplitude modulating an RF signal. The visual and audio information are coded as strings of 1s and 0s in the form of pulses modulating the RF signal.

So long as there is sufficient signal strength for the decoder to decode digital data, a perfect picture will result. If the signal strength falls below that level, the system loses its ability to maintain picture and sound; it crashes and no reception is possible. There is no gradual deterioration of picture quality with increasing distance from the transmitter, as with NTSC. Thus, there are no grades of coverage; it is either all or nothing.

> With ATV coverage, there are no grades of coverage; it is either all or nothing.

Based on the reception planning factors used by the ATV Field Test Subcommittee in calculating ATV service, minimum signal strength levels for ATV service have been calculated for each channel from 2 through 69. There are large propagation disparities between the different channel groups. Channels 2-6 require signal strengths in the 20-30μvolt per meter (μV/m) range. For Channels 7-13, the requirement is around 60μV/m, and for UHF, it varies from 120μV/m to 200μV/m.

The spectral power distribution is almost uniform across the channel when the carrier is suppressed. To make the RF components transparent to such a sideband signal, each component should demonstrate a uniform amplitude response, as well as a linear phase response across the 6MHz band. Minor imperfections in the RF system response can be corrected by using channel

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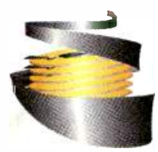

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equalization techniques.

The operating power for the new digital ATV is estimated to be 10-13dB below, or 5-10% of, the equivalent operating power for NTSC. Unlike the NTSC spectral power distribution, the digital ATV power is almost uniformly distributed over the channel. Because of the uniform distribution, tough requirements are imposed on the wideband response of the RF components and antennas.

Key RF issues

The most important issue in deciding on an RF system for digital ATV is minimizing the distortions to the digital ATV signal, such as group delay, phase nonlinearity and ripples in the amplitude response. The digital ATV signal passes through filters, combiners and transmission lines, and is naturally affected by the response of these components. The total degradation in the signal is the sum of the degradations caused by each individual component. Bearing this in mind, it is to your station's advantage to minimize the number of components, such as combiners and filters, and design carefully for the use of waveguide.

The antenna must be designed and planned carefully to minimize potential distortions from the radiator. The key issues to be concerned with from the aspect of the ATV antennas are pattern stability, phase linearity and group delay. Pattern stability is a measure of insensitivity of pattern shape to frequency across the channel. Stability of patterns in azimuth and elevation planes are mostly a function of the antenna type. Pattern stability also depends on the support tower in those cases where there is the potential of scattering caused by the tower. The azimuth pattern stability usually depends on the radius of the radiator (or radiators, in the case of panel antennas). Slot antennas usually demonstrate better azimuth pattern stability than panel antennas. Patterns with deeper azimuth nulls have less pattern stability.

The typical elevation patterns of the branch-fed antennas demonstrate reliable stability within the angle of the main beam. Antennas fed from the end demonstrate some minor beam scan, which is insignificant in the main beam angle area but could result in a variation of the received field in null areas. Therefore, the end-fed waveguide slot antennas should be carefully designed for their suitability for digital ATV systems because of the dispersive nature of waveguides. For digital ATV, the azimuth circularity of the antenna patterns is not as crucial as it is in the case of NTSC. Unlike NTSC where the quality of reception is critically dependent on the quality of the strength of the received signal, successful reception of the digital ATV signal depends only on the recognition of pulses after demodulation. A perfect picture is usually possible at lowest levels of field, until fall-off. ■

Louis Libin is director of technology, NBC, New York.

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Distributing digital audio

Routing and switching digital audio signals is not a simple task.

By David L. Bytheway

THE BOTTOM LINE:
Many users expect digital audio to solve all of their facility's audio problems along with improving quality. Unfortunately, this technology is not the panacea that many had hoped for. Although it offers plenty of advantages, many misconceptions remain on the implementation of digital audio systems. Perhaps the most vexing is the issue of noise-free digital audio switching. $

Many facility engineers today are establishing AES/EBU digital audio signal distribution systems. Implicit in this task is the capability of signal switching in the digital domain without pops, glitches or other noises.

In the analog audio world, this goal was not difficult to achieve. Yet, the digital audio signal is fundamentally different from an analog one: it is a *sampled* signal. This simple fact changes all the rules. Sampled signals do not respond to switching the same way that analog signals do. Three basic problems must be addressed in order to realize the desired "silent switching" between AES/EBU signals.

Synchronization

The first issue is synchronization. In switching and mixing two digital audio signals, the sample rates of the two signals must not only have identical sample rates, but they must be *locked* together. If the two signals are not locked, it will be practically impossible to find a point to switch between them without damaging a sample. Synchronization is a familiar process to video engineers, but it is new to many audio engineers. Nevertheless, it has become essential for most audio operations in today's teleproduction or broadcast facilities.

Signal sources are usually synchronized by connecting a sync or reference signal to all signal sources. If a source cannot be synchronized, the only real solution is to provide sample-rate conversion to bring all non-synchronized signals to the "in-

This audio room at CBS Television City requires flexible interfacing of analog and digital audio signals. (Photo courtesy of Solid State Logic.)

house" standard before switching or mixing. Fortunately, several manufacturers are now making relatively low-cost (compared to the past) chips that perform this rate conversion. These parts are being incorporated into many digital mixers, but they are not usually used in switching equipment. Sample-rate converters also must be used carefully because the rate-conversion process is not transparent. Distortion is always added in the process.

Timing

Timing refers to the alignment of digital signals' AES/EBU frame boundaries so that switching can take place without damage to any signal's samples. This is only possible if the signals to be switched are already synchronized. Some switching equipment provides the ability to automatically align the frame boundaries. This is usually done by decoding the AES/EBU bitstreams of the two signals being switched, then feeding this data into either a double-buffer or a FIFO-type memory. The two signals are clocked out of the buffer or FIFO based upon a local reference signal (usually provided by a sync or reference input to the device). Switching then takes place at a point in the AES/EBU bitstream that will not cause sample damage, such as at the end of the preamble denoting frame boundaries. Damaged samples can make a loud tick or click sound.

Switchers that do not automatically provide time alignment may require cutting of cables or adjustment of the source timing to provide proper alignment of incoming signals. In practice, this can be a nearly impossible task for typical digital audio devices. In anticipation of the problems, a recommend-

Distributing digital audio

ed practice was developed by the AES called AES11-1991 (ANSI S4.44-1991) entitled "AES Recommended Practice for Digital Audio Engineering: Synchronization of Digital Audio Equipment in Studio Operations."

An automatic timing scheme is defined in this recommended practice, which defines certain timing windows that inputs and outputs must follow in order to avoid cutting cables to timed lengths. Devices that follow this standard will provide a reference input and some method of accepting synchronized but out-of-time inputs.

Dissimilar signals

Even after the two problems just mentioned are solved, there still exists the problem of *dissimilar signals.* A sampled signal does not respond to a disturbance in the stream of samples in the same way as a sudden interruption in an analog signal. Simply stopping a signal at a sample boundary will not give a pleasing result.

If you plan to use a digital audio switcher to present signals to the air chain, you should carefully study this effect. When switching is done between two synchronized and timed signals during silence, such as between two programs, the result can be acceptable in most cases. Many such switching systems are available. But these systems cannot guarantee that all switches will be glitch-free 100% of the time.

When one or both of the signals involved in a switch are "active" (not in silence), there can be an audible pop or click created at the switch. This is not the result of synchronization or timing problems, but is a simple fact of life with sampled signals.

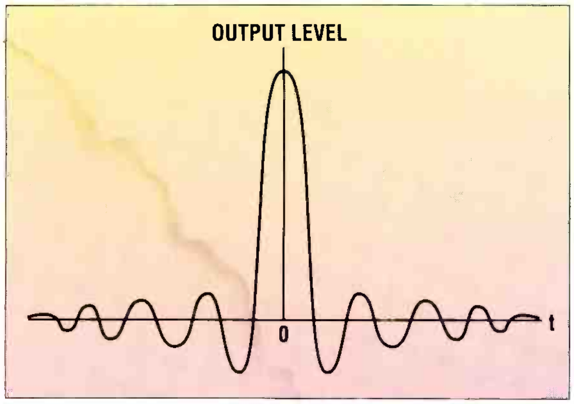

Figure 1. The waveform of a single digital audio sample exhibits the familiar sinx/x function.

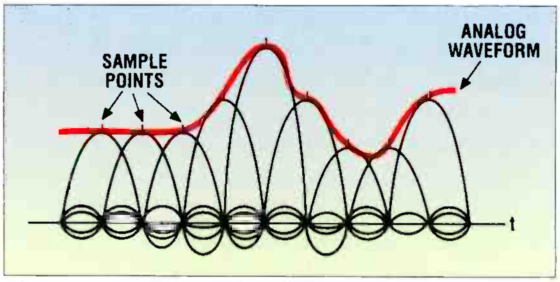

Figure 2. A portion of an analog audio waveform that results from the summation of a number of sequential samples' waveforms. Note that at the center of each sample's waveform peak all other waves converge at zero value. Thus, the resultant analog waveform is the same as (i.e., intersects) the sample values at the sample points.

To illustrate this problem, consider the time domain responses of digital audio samples. A single audio sample heard alone will sound like a click. It is actually the sound of an impulse and has the waveshape of a sinx/x curve. A signal such as this was often used in early CD player evaluation and can be found on many CD test discs. It was used to test the output polarity of a CD player, but could also be employed to show ringing of the D-to-A conversion process. Careful examination of the resulting analog waveform will show the classic sinx/x shape. (See Figure 1.)

Each digital audio sample has this waveform, and it is only when all the waveforms of adjacent samples are added that the analog audio output waveform is created. It takes a sequence of many samples (both before and after

Continued on page 38

Connecting in the analog/digital audio world

By Bernard Weingartner

One of the proverbial questions in the audio industry is, "When do you think everything will be digital?" It may never happen, because human beings will remain analog communicators as will most acoustic musical instruments. This makes transducer manufacturers and the makers of connectors and wire happy, because it means that microphones and their paths to the A/D — as well as speakers and their paths from the D/A — will remain in the analog domain for quite a while.

Meanwhile, digital connections and paths will coexist with these analog systems. The pace at which digital will overtake analog will likely vary between market segments, however. It will happen quickly in the audio-for-video environment (where users are dealing with wide bandwidth already), followed by home recording (with more robust and forgiving requirements) and then automated broadcasting where much data handling is already in place.

Little digital application is seen in smaller PA installations where price is the leading issue, as well as in larger PA systems for live concerts although they have quite a bit of digital outboard equipment already in use. As far as the large recording studios are concerned, there is no clear picture: Coexistence of analog and digital worlds seems likely to stay that way for some time.

What digital transmission technically means is simply applied RF technology — transmission-line theory — which encompasses terms like propagation resistance, reflections, standing waves, impedance matching, line bandwidth/attenuation, and more important, electromagnetic interference (EMI) problems (incoming and outgoing) where fairly stringent rules prevail in Europe.

(A simple test can help to check the presence of possible EMI between two digital devices: Set them side by side, one input cable and one output cable of 10-foot lengths, 110Ω terminated, paralleled close to each other but not connected, and set a sampling rate of one unit to 44.1kHz and a sampling rate of the other to 48kHz. No interference tone must be audible.)

Therefore, new quality parameters for connectors and cables apply, such as correct and uniform wave propagation

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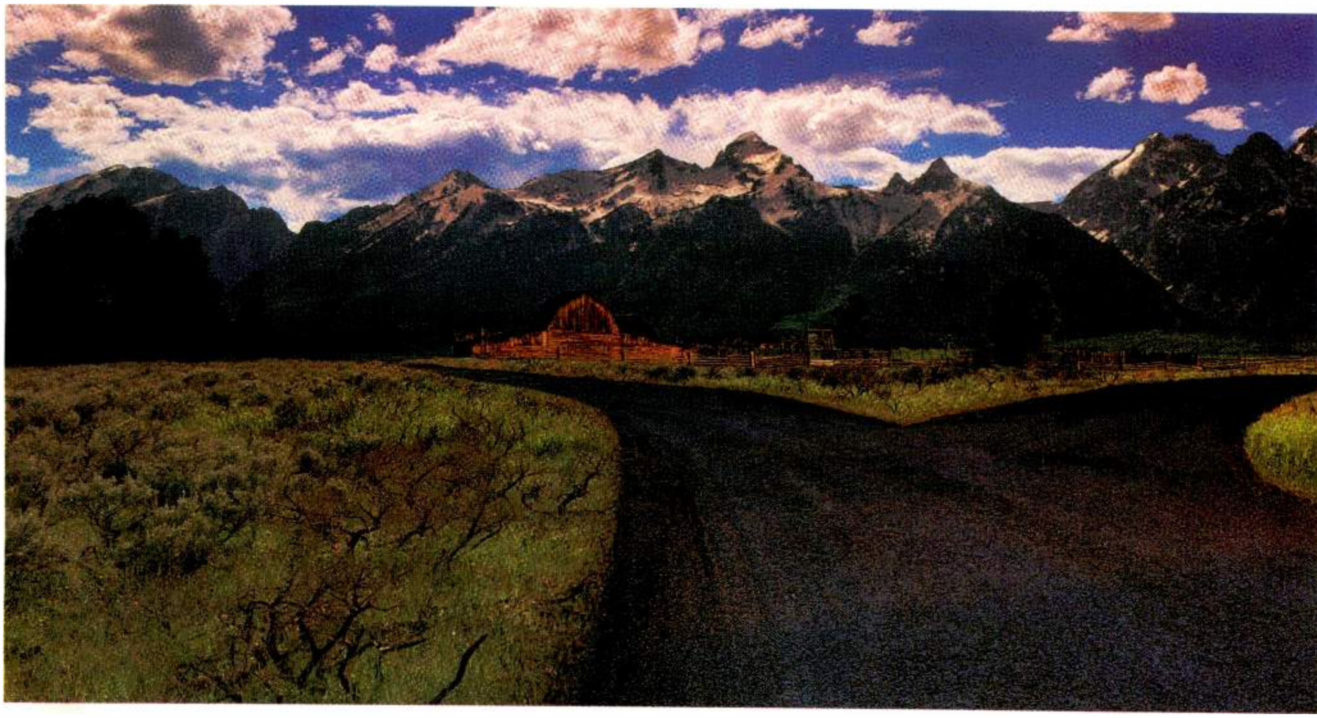

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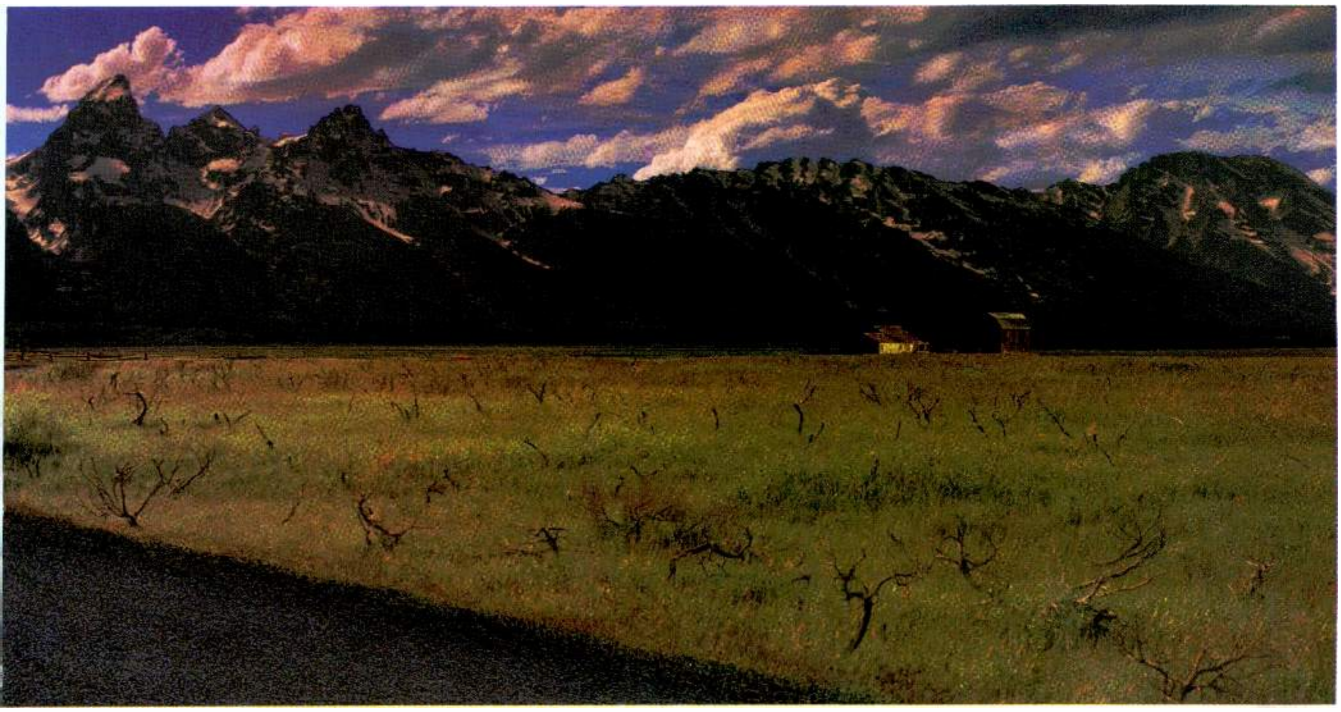

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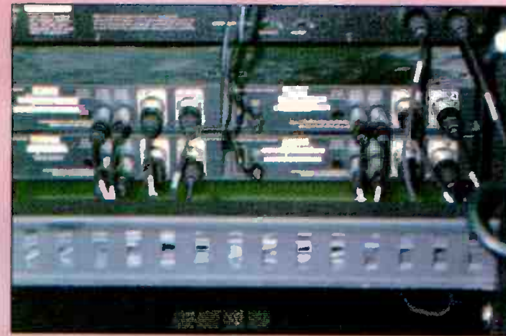
resistance (WPR) or uninterrupted and consistent shielding (including the connectors). Important questions in this context include: Is there any danger of jitter induced by mechanical movements of cable and or a connector? Is the grounding system well-designed throughout?

In the pure digital environment, the final solution will be the coaxial cable (75Ω) and associated RF connectors, a subtle challenge for audio users and "analog connector" manufacturers. In the mixed world of analog and digital, the XLR with 110Ω shielded, twisted-pair cable will prevail, as specified by AES/EBU recommendations. The ideal shielding/grounding technique for this connecting system is a consistent coaxial shield where all XLR connectors are linked together via the cable shields, and linked to the equipment "coaxially," with as low a resistance as possible. This would solve the well-known "pin 1 problem" in the analog domain (although it must be said that for some normal applications a proper, short-as-possible wired shield-connection via pin 1 to chassis is an acceptable compromise).



Today's audio systems still require a variety of connectors, handling analog and digital audio of several formats.

The XLR connector is so short compared to the wavelengths in the cable that its theoretically larger WPR causes no reflections. What is more important is a good contact (gold instead of silver) and a stable, low shell-to-shell resistance.

Regarding cable quality/specifications, it is recommended to use precise, short twisting, good isolation of the conductors and a tightly wound spiral shield with at least 97% persistent coverage.

Another issue of the 110Ω technique concerns the use of patchbays. The patchbay must be a low-capacity version with a manufacturer's declaration that it is "digital capable" or able to pass AES/EBU digital signals without distortion.

Finally, check whether input and output impedances of digital equipment is really 110Ω ±10% and that "RF termination rules" are observed throughout. (For example, if you parallel two devices of 110Ω each, you have to provide 110Ω serial resistors to each input.)

As a rule of thumb, digital audio transmission over a standard unbalanced audio cable/connector (usually around 60Ω to 80Ω) should cause no problems over cable lengths of around 30 feet end-to-end. With good twisted-pair cable, the minimum length extends to about 10 times longer (300 feet) with a maximum of 10 connecting points inserted.

However, it is not recommended to use unbalanced (RCA) connectors for professional analog audio because such wiring risks interference problems and a distorted analog signal can never be restored like digital signals can. ■

Expect to see new and refined connector designs that will continue to improve on the analog and digital hybrid audio interfacing requirements of broadcasters. ■

Bernard Weingartner is president of Neutrik AG, Schaan, Lichtenstein.

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Distributing digital audio

Continued from page 32

any given, single sample), with each sample adding its unique contribution, to create the continuous analog waveform values that "connect" (i.e., fill the space between) sample points. Figure 2 shows a portion of an analog waveform that is the result of the summed response of the individual impulse responses of each sample.

When a digital audio stream is disturbed or truncated, the "side lobes" of the sinx/x curves cannot add properly as they do in Figure 2, and the resulting waveform may have a large transient or click. When the digital audio streams of two dissimilar waveforms are butted together as in a switch, the resulting waveform will not necessarily be pleasant sounding. The side lobes of each

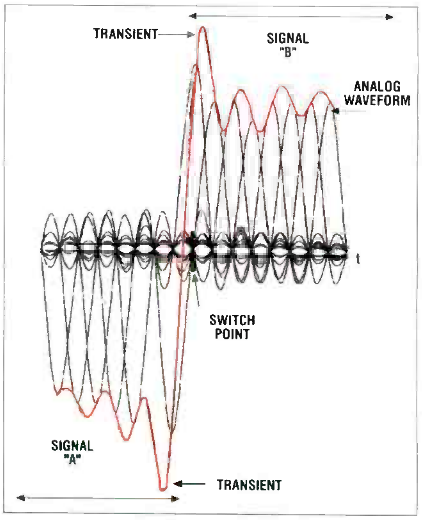


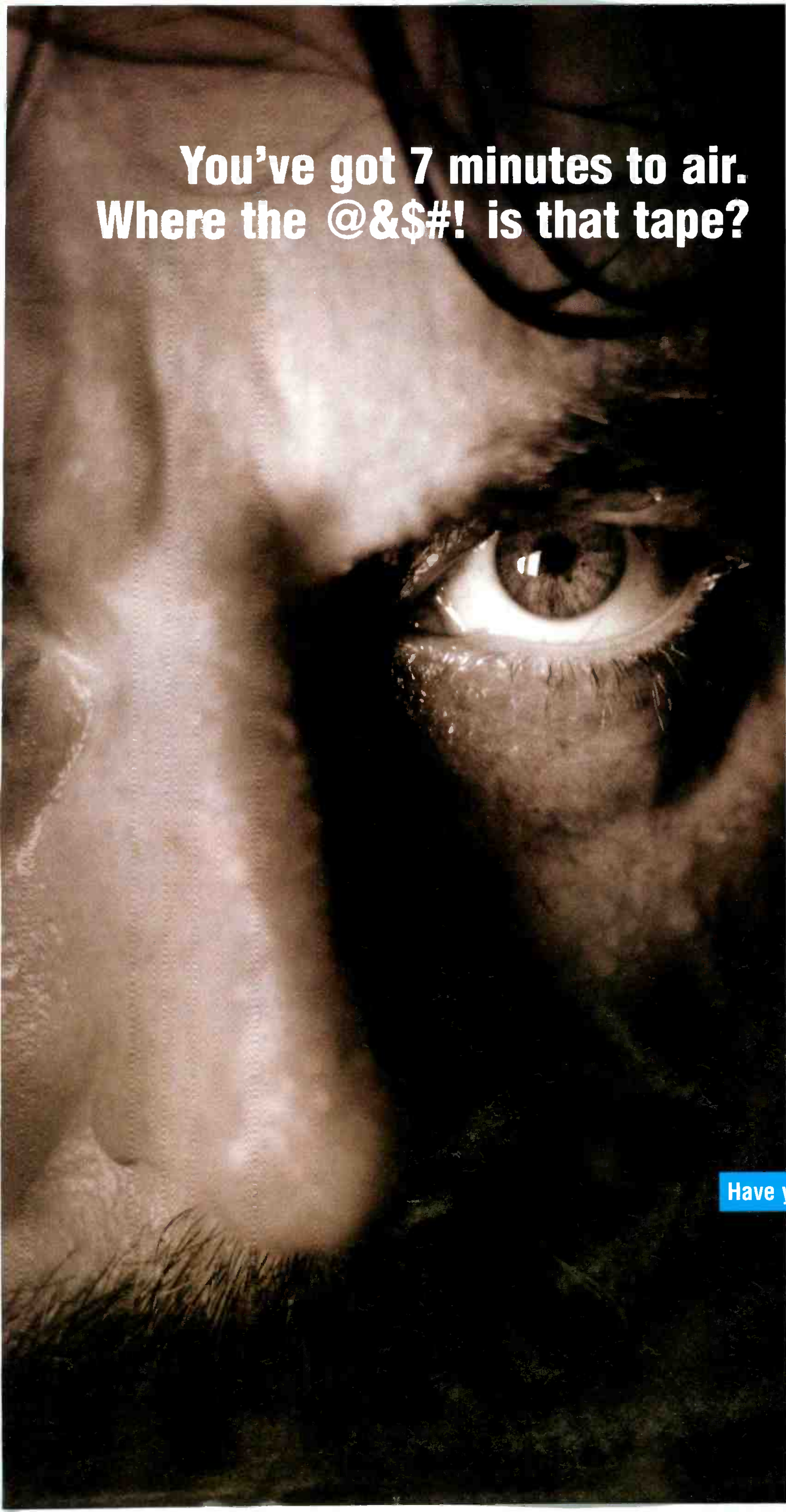
Figure 3. A portion of the analog audio waveform resulting from a switch performed between two dissimilar digital audio signals (A and B). Note that summation results in an erroneous analog waveform that travels above and below the sample values between sample points. (Compare to Figure 2.) This disruption is usually manifest as an audible click or pop at the switch point.

signal do not add up as they would in an undisturbed signal and, therefore, an audible click is produced, as shown in Figure 3.

The sound of each switch will be dependent upon the exact signal conditions at the switch point. Sometimes these switches will be transparent and other times a noticeable click will occur. This problem exists in today's digital switching and digital editing equipment. Editors began to learn several years ago that simply butting up two digital audio cuts on a digital editing system could cause problems, and the issue is now well-known among experienced users.

The real solution

When totally clickless audio presentation is the goal, more than synchronization and timing are required. The real solution is to produce either a cross-fade or a "V-fade" between the two signals. A ramp of attenuation over many samples (usually in the hundreds to thousands) will produce a pleasing result. This is usually done with digital signal processing (DSP) techniques. Both signals involved in a switch (signal "A" and signal "B") are presented to the DSP. The outgoing (A) signal is faded to silent over many hundreds of samples, and then the incoming (B) signal is faded to full over



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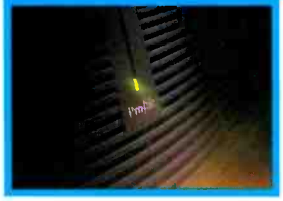

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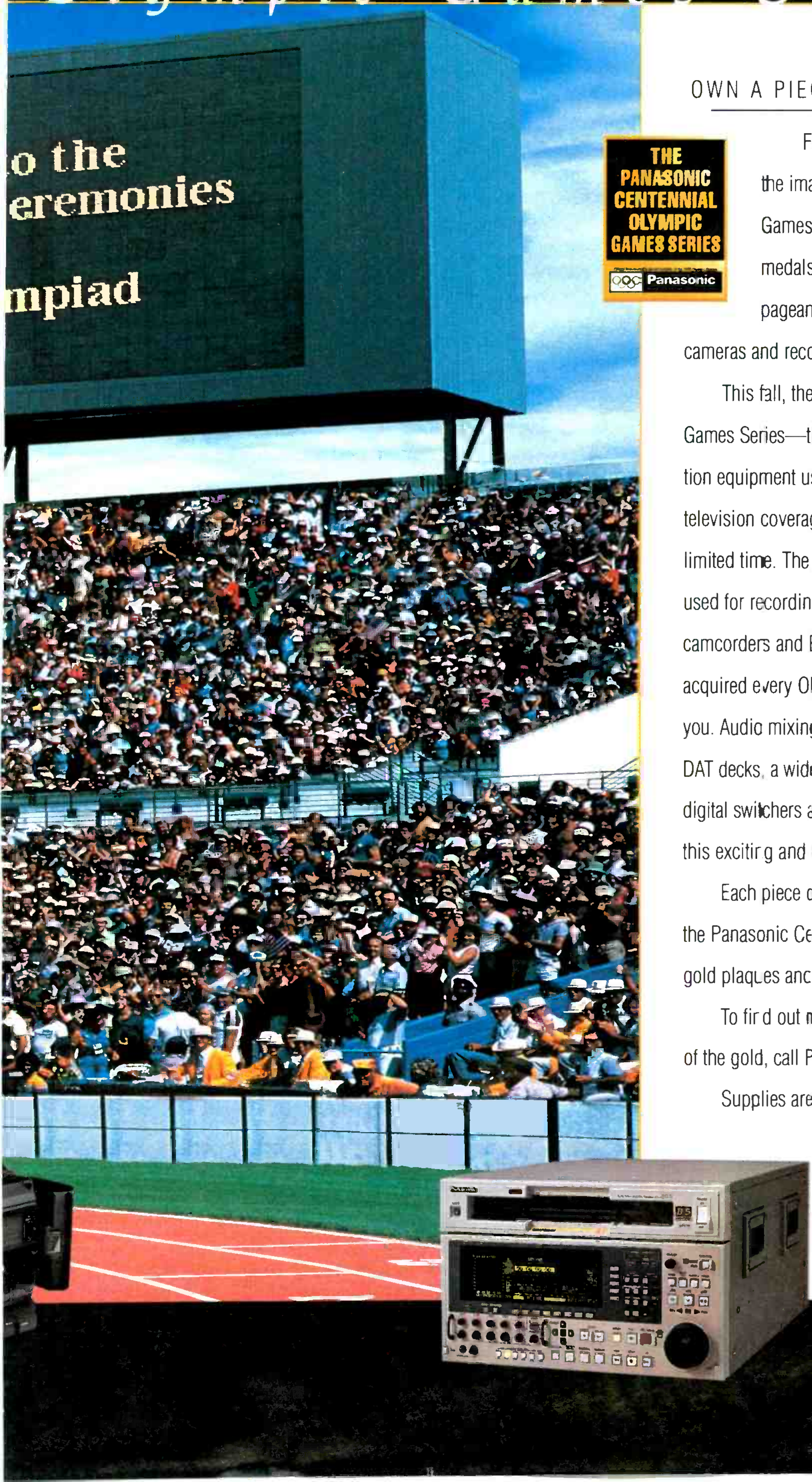

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many hundreds of samples. This quick V-fade will result in a smooth, click-free transition between signals.

That approach is the only sure way to produce a perfectly clean output signal from a digital audio switcher. Once this fact is acknowledged, the question that inevitably comes up next is, "Do I really need to do this on all of my switcher outputs?" The answer will usually be no. Most switching (such as that performed by a facility's routers) does not occur during the program audio and, therefore, the sophisticated and generally expensive DSP devices required for 100% clean switching will not be needed. For digital switching to air, however, such devices are mandatory to deliver consistent, quality presentation. Without such precautions, hot switching and digital audio signals simply cannot coexist. ■

David Bytheway is a principal engineer at Philips Broadcast Television Systems Company in Salt Lake City, UT.

FOR MORE information

Circle (203) on Action Card. See also "Routing Switchers," p. 70 of the *BE Buyers Guide*.

Converting your facility to digital audio

By Otto Svoboda

The lure of digital equipment has included guarantees of higher productivity, increased efficiency, greater cost-effectiveness. . .you've heard it all before. While this may be true, it's not the whole story. The sales pitches generally forget to mention that these amazingly powerful digital tools allow you to create a product with such fine detail and resolution that the time you might have saved is taken up by fiddling with minutiae in the quest for perfection.

More specifically, many products look great from a distance, but their luster fades as you learn their limitations. For instance, the DAW you thought had 99 tracks and super punch-in capability actually can only playback eight tracks (or punch-in two tracks) at a time, and even this takes extensive keystroking.

But I digress. The real challenge for any facility is to find the places where new digital technology can provide the most benefit today, balanced with the places where it makes sense to keep existing analog technology around for a while. Ideally, you'll have a rough master plan for this transition so that today's choices will fit nicely into tomorrow's realities. The process is a slow but progressive integration of digital audio into the working environment.

A case study

At the CBS Television City facility, daytime dramas, game shows and talk shows are the mainstays, with sitcoms and variety shows that come and go. The seven production studios feature a variety of recent analog consoles, including three SSL 6000s, two SSL 8000GBs, one Neve 8148 and one Yamaha PM4000. Digital finds its place in these production studios as storage media. Music playbacks almost always come from a 360 Systems Digicart. One of the daytime dramas uses Digicart I for music playbacks during production and its entire music library is stored in the form of Bernoulli discs that play on these recorders. One of the game shows uses Digicart I for its music playbacks while a talk show uses Digicart II for its bumpers.

The tasks of production sound effects and live sweetening ("canned laughs") belong to AKAI S3000 samplers with Roland MIDI controller keyboards. (When *The Late Show with David Letterman* originates in Los Angeles, it's not uncommon for SFX man Howard Vinitski to use multiple samplers and keyboards that could be mistaken for Paul Shaffer's synth rig.) The outputs of these devices are typically mixed in the analog domain and recorded to D-2 or Digital Betacam.

Post-production needs

Post-production sound has taken greater advantage of digital audio, not only because of its sound quality but also because of its random access and enhanced editing capabilities. Nevertheless, finding just the right DAW for the facility's regular post-production jobs has been difficult. Initially, the DAW was thought to be able to replace a large analog console, an analog 24-track recorder and an SFX operator. Needless to say, this was not what happened. It's a perfect example of how important it is to compare your needs to what a system under consideration can actually deliver.

This is harder than it sounds because there are so many variables. You should not only study your situation, but try to use your target DAW in a real-time session. The last thing you need is to find out after making a major expenditure that this overwhelmingly powerful device cannot perform some of the regular functions you and your clients have been used to doing.

Consider putting together a scenario of your typical requirements (and maybe a few new items from your wish list) and presenting it to the various DAW representatives. See what comes back and make your decision. Remember that equipping a new facility with the latest "conventional" systems (or a hybrid of new and conventional technologies) is still a viable option.

What's next?

It's pretty clear that the future holds a continuing conversion from analog to digital for practically every facility in the business. For production and post-production, an all-digital console with the space requirements and flexibility of current analog consoles, plus the processing power of DSP, is a sensible goal. Combined console/recorder packages continue to stir interest, as well. Eventually, the audio signal will remain digital from the microphone pre-amps to the recorders, bypassing all intermediary D/A and A/D conversions. In post-production, true multitrack capability (without virtual-track and I/O limitations) is another goal.

Finally, it's important to keep updating your awareness and your list of needs. With digital technology changing so fast, so could your purchasing plans. By keeping your ears and eyes toward the future, and with a little bit of luck, you'll make the decisions that will keep you ahead of the game.

Otto Svoboda is an audio mixer at CBS Television City, Los Angeles.

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RAID disk arrays of video servers

RAID systems are far more than just a bunch of disks.

By Bill Moren

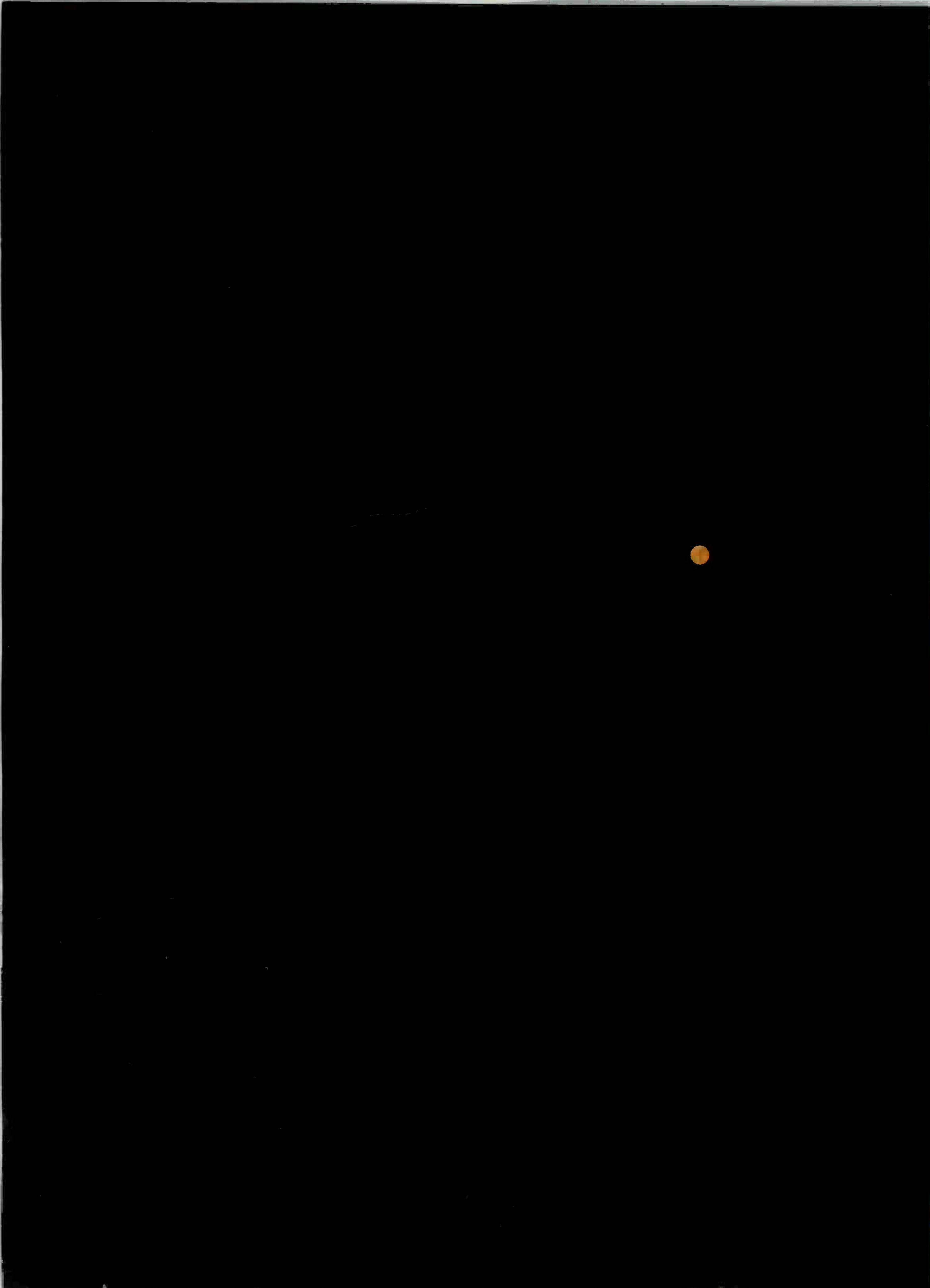
THE BOTTOM LINE:
Moving from tape to disk equipment can be expensive. The trade-offs include reduced maintenance and higher reliability, however, in today's business climate that is not enough. New systems must be cost-effective. In addition video servers, like most broadcast equipment, must provide some level of redundancy. How that redundancy is implemented can affect system performance. Poorly optimized systems are usually not cost-effective. $

The convergence of video production, broadcast, communications and digital computing has spawned a new class of computing system — the video server. The video server is related to its cousin, the file server, because both "serve" data to fulfill requests from clients. *Serve* refers to the action of retrieving data from digital storage and forwarding it to the user via a communication's network. Video servers, not withstanding their similarities to file servers, have performance demands placed on them that make the architectures employed unique. A key component of these architectures is high performance, redundant disk storage.

The video server paradigm

Video servers are used to deliver digitized video data to a communication outlet (for distribution of the video) in real time. Upon request or on a pre-programmed schedule, the video server must retrieve video (which has been digitized and compressed) from on-line storage and forward it through system buffers to a communication outlet for transmission

Large RAID arrays are required for a variety of applications including video servers, animation and graphics. (Photo courtesy of Ciprico.)



RAID disk arrays of video servers

to the viewer. This process must be performed in real time to ensure the video is delivered at a continuous rate of 30 frames per second (fps). A typical video server environment is shown in Figure 1.

The video server is typically a powerful workstation with hardware and software designed to deliver video in real time. The hardware architecture of video servers must allow for many streams of video to move from the on-line disk storage through internal system buffers and out through communications connections. While any of these components could limit the server's performance, it is the disk subsystems which, if improperly designed, have the potential to degrade performance by 50% or more. Furthermore, because the disks in a video server account for about 50% of the server's cost, anything less than optimal configurations can dramatically impact the server's cost-effectiveness.

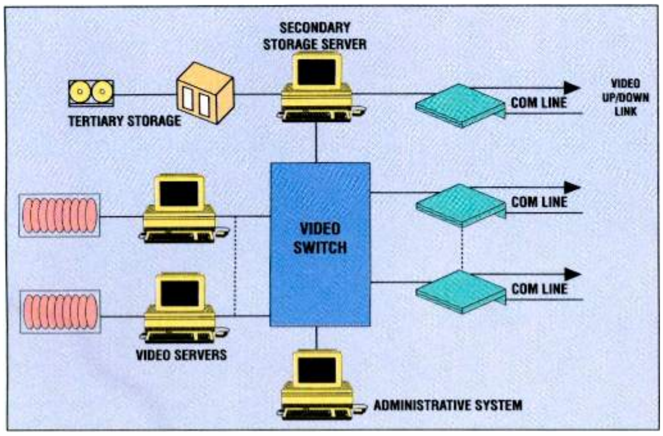


Figure 1. Video servers are used in conjunction with video switches, communication links, administrative systems and various methods of downloading content.

Unlike file servers, which manipulate data of any type, the video server's sole task is to retrieve video data. The video data stored on a video server consists of programming that has been digitized and compressed. Typically, there will be a large number of different titles stored in the video server, of arbitrary length (depending on the type of video — movies, news, commercials, etc.). Each title may be played at differing times. Also, multiple copies of the same title may be active simultaneously. Advanced server software, typically found on systems serving metropolitan areas, may schedule multiple requests for the same title into slots, eliminating redundant data requests. For each slot, regardless if single or multiple video requests are being serviced, the video server must supply a single video stream.

The sequence of digitized data that comprises a piece of video, when transferred in such a fashion as to satisfy a viewer's request, is said to be a stream. A stream is sequential, in terms of chronology and not how it is organized on a disk subsystem. In practice, video streams are typically stored sequentially for performance reasons. If a viewer pauses or rewinds, a new stream is generated when the playback resumes (at least from the video server's perspective). Video servers typically support numerous simultaneous streams. For performance modeling, a random distribution between streams is often assumed. Video streams also have isochronal characteristics. Specifically, each frame in a video stream must be delivered every 33ms (time per frame at 30fps). For acceptable video playback, the server can't deliver video on an average of 30fps (e.g. 60fps for one second, 0fps the next). Within the server, the method used to provide isochronous performance may accommodate some components' inability to operate truly in an isochronous mode. For instance, system buffering may allow disk subsystems to load a sequence of video into the server at a rate much faster than 30fps. The server then transfers out of the buffer at precisely 30fps. Fault tolerance is another key video server trait. It is not unusual for video server applications to operate 24 hours per day, seven days per week.

Video server disk storage

The fundamental objectives for video storage are straightforward. First, the storage should be as cost-effective as possible. This implies that the storage subsystem employs an architecture that delivers the highest stream to spindle ratio possible. This ensures maximum performance for the lowest cost. Second, there must be adequate capacity for the total content to be available online. Finally, the storage must be fault tolerant, enabling real-time operations.

Individual disk drives do not satisfy the objectives set for a video server's storage. A single drive delivers only a few streams of compressed video. To determine the number of streams a disk can deliver, several variables need to be considered: the request size of the stream, the drive's sustainable bandwidth, the drive's access latencies and system overhead.

The total number of streams (S) a drive can support is the ratio of the time per request at the compressed video rate (Tv) and the time per request at the sustainable disk rate(Td) {S=Tv/Td}. A request is the transferring of an arbitrary amount of data in a unitary disk operation and typically encompasses many frames of video.

Tv (time at video rates) is simply the amount of data requested (L) divided by the video stream rate (Rv), after compression (typically 1-15Mb/s). Td (time at disk rates), on the other hand, consists of the sum of the drive's latencies and the time for the actual data

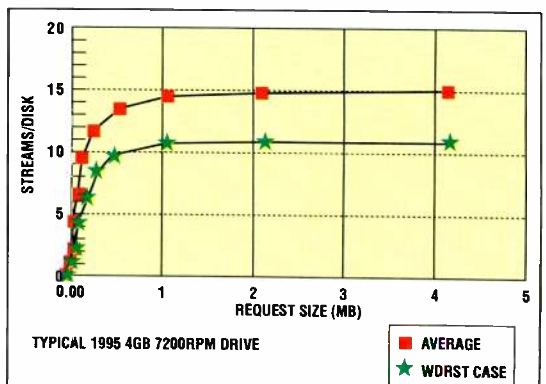


Figure 2. Average and worst-case performance of a 7,200rpm drive when supporting multiple 3Mb/s video streams.

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transfer (Tx). A drive's latencies consist of a seek (Ts), a rotational period (Tr) and overhead (To). (For more information on drive latencies, see "Disk-Based Servers for Production and Broadcast," December 1995.) Data transfer time (Tx) is request length (L) divided by the drive's data rate (Rd).

Expressed algebraically, the total number of streams a single drive can support is:

$$S=L/((L/Rd+Tx+Tr+Ts+To)*Rv)$$

For example, a 7,200rpm drive with average access times of around 13ms and transfer rates of around 6MB/s will support approximately 15 streams of video compressed to a rate of 3Mb/s. This same drive, if worst-case performance is evaluated (full-throw seeks, full-revolution rotational latencies), only supports about 10 streams of video at the same compression rate. For better-quality video streams (e.g. lower compression), which require higher data rates, the number of streams supported by this class of drive drops. Figure 2 depicts graphically the performance of this type of drive for varying data request lengths (L).

While a single drive has modest stream performance at best, the capacity is also rather small in the context of video. Video compressed to 3Mb/s requires more than 22MB of storage for one minute of playback. On a 4GB disk, approximately 180 minutes of capacity are available, enough for only about one and half movies. For a server with any reasonable total capacity, many spindles (drives) will be required.

Regardless of the total number of drives used in a video server, media redundancy is required to ensure on-air real-time playback. Even though mainstream drives have high mean time between failures (MTBF) ratings, they do fail and at a rate that may be surprising. For a family of drives with an MTBF of 800,000 hours, the expected failure rate over the service life of the drives is more than 5%. This analysis assumes no drive design failures in either the hardware or microcode, nor any manufacturing process problems endemic to a particular lot or facility. (For more information, see "RAID Storage Technology," August 1995.)

RAID for video servers

A storage technology referred to as redundant arrays of independent disks (RAID) addresses the performance, capacity and redundancy needs of video servers. RAID was conceptually presented in a paper published by the University of California at Berkeley in the mid-1980s. The paper offered a series of data storage architectures that provided media redundancy, large capacity and high performance. The architectures are colloquially referred to as RAID levels and were arbitrarily numbered one through five to identify each level.

RAID level 1 (RAID 1) is disk mirror-

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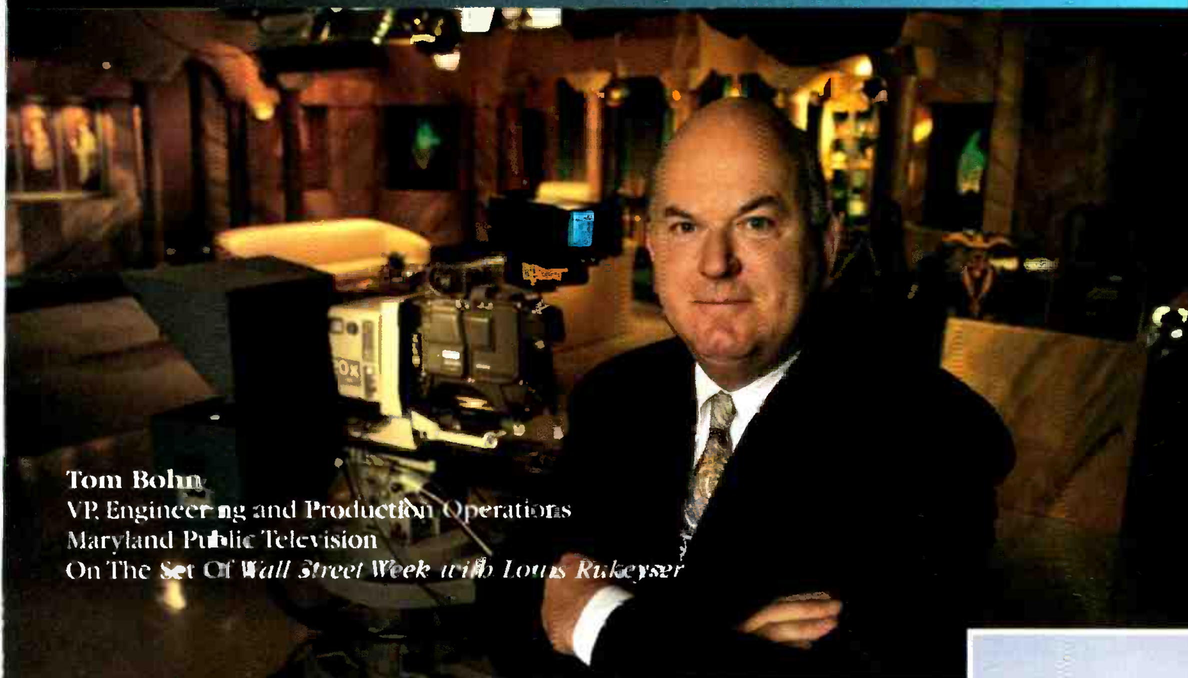

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Tom Bohn feels the change from 4:3 analog to 16:9 digital technology "will be a revolution every bit as big as black-and-white to color. And since we don't know what the standards will ultimately be, we must start to future-proof now."

As he invests in new technology, Bohn looks for upgradeability on each piece of equipment. That's one reason he purchased eight Hitachi digital cameras. The SK-2000 Series has four built-in upgrade paths, from the single LSI processor, and A/D converter, to the newest CCD block technology.

"As the fourth largest producer of PBS shows, MPT creates programs with very long shelf lives–which makes 16:9 digital capability crucial. So we needed a camera that was digital from the head all the way through the CCU. I personally visited all the factories and trade shows, and I found Hitachi to be two years ahead of the competition.

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ing. Mirroring is a technique common to mainframe storage architectures and pre-dates the RAID paper. It was used as a frame of reference in the paper for the other RAID levels presented. Mirroring provides redundancy by simply duplicating each disk in the storage system. The remaining RAID levels incorporate a data-striping technique in which data is evenly divided across a group of data drives. Error correction information, which can be used to regenerate the data on a failed drive, is stored on a redundant drive. RAID levels 2 and 3 stripe the most elemental unit of data, the disk block, across all data drives. The difference between these two levels is the redundancy technique, in which RAID 2 uses multiple redundant drives, while RAID 3 uses a single drive. Because RAID 2 offers no significant benefit over RAID 3 and has higher costs, it has not been considered a commercially viable alternative, and won't be considered further. RAID levels 4 and 5 stripe blocks with a single or group of blocks entirely contained on a single drive. Like RAID 2 and RAID 3, the difference between RAID 4 and RAID 5 is in the method of redundancy. RAID 4 stores its error-correction data on a dedicated drive while RAID 5 distributes this information across all drives. Although RAID 4 may be easier to implement, it offers lower performance and no cost savings as compared to RAID 5, and it too will not be considered further.

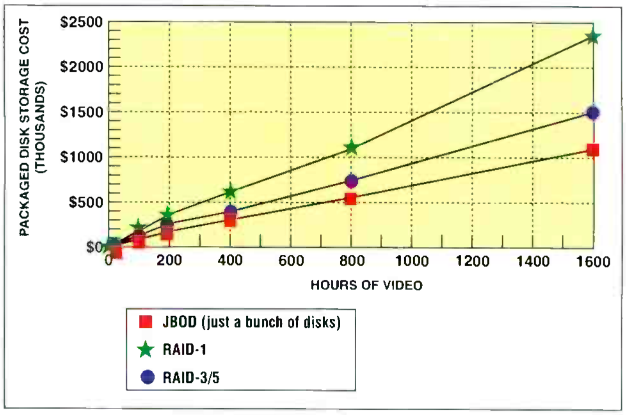


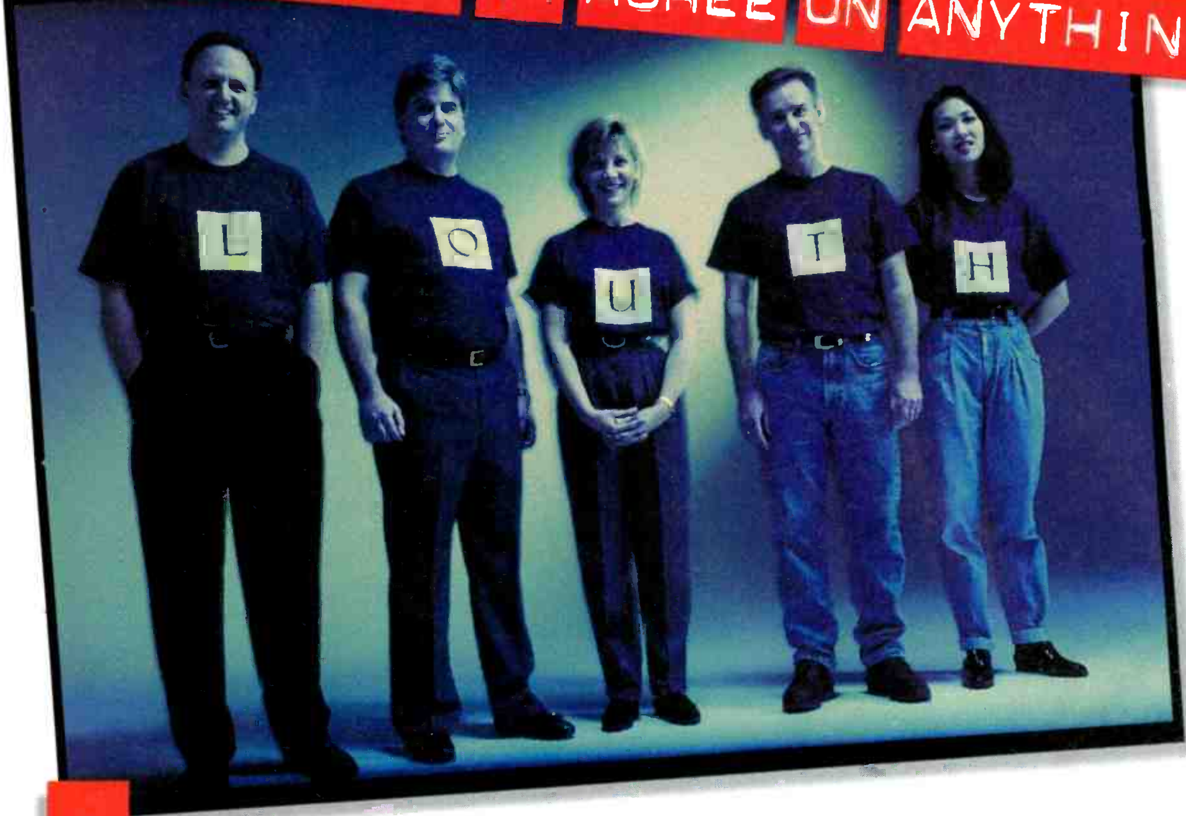
Figure 3. Media cost differences between various disk storage systems.

RAID 1, RAID 3 and RAID 5 share a common trait; any single drive in a RAID configuration may fail and all the data stored in the RAID will remain accessible. The similarities end there. Each of the RAID levels have differing levels of normal performance, performance after a failed drive and media costs. These differences define the suitability of these RAID levels for video server applications.

Selecting RAIDs for video servers

While the old adage "your mileage

HOW DO YOU GET FIVE DISK SYSTEM MANUFACTURERS TO AGREE ON ANYTHING?



Actually, when it came time to standardize on one disk interface protocol, it wasn't that hard. The top ten manufacturers of disk systems overwhelmingly chose The Louth Protocol.

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may vary" is appropriate when considering different vendors' RAID implementations, a good understanding of the underlying RAID principles will remove any doubt as to the upper limits of each RAID level. To compare the RAID levels, configurations using "n" drives will be considered. The table compares four important metrics for each RAID level. The first metric to compare is the media cost. It is in this comparison that the primary detriment to RAID 1 becomes apparent. RAID 1, because it must duplicate every disk, requires twice the total number of drives needed for any arbitrary capacity objective. As a result, the total cost for a usable capacity equal to n drives is 2n (100% premium). By comparison, RAID 3 and RAID 5 (RAID 3/5) only consume one drive's capacity for redundancy. As a result, the premium for redundancy is only a fraction of the total capacity purchased. A five-drive RAID 3/5 only requires one disk for redundancy, 20% of the total. As the width of the array increases, the premium decreases even further. A nine-drive array, eight of which are usable, has a redundancy premium of only slightly more than 10%. In general, the cost for "n" usable drives in a RAID 3/5 configuration is (n+1)/n. Figure 3 illustrates the difference in redundancy premiums for RAID 1 and RAID 3/5 as compared to just a bunch of disks (JBOD), with no redundancy whatsoever. In addition to RAID 1's much higher cost for redundancy, the large number of drives associated with RAID 1 also increase the packaging and cooling complexities of a system, while lowering the overall reliability due to the larger total number of components. As a result, RAID 1 will not be considered further.

RAID LEVEL	PERFORMANCE NORMAL	PERFORMANCE FAILED DRIVE	USABLE CAPACITY	PREMIUM FOR n USABLE DRIVES
1	n	n-1	n/2	2n
3	n-1	n-1	n-1	(n+1)/n
5	n	n/2	n-1	(n+1)/n

Performance criteria for various RAID levels using "n" drives.

The popular convention is to consider striping RAIDs for use in video servers. Because the media costs are identical for RAID 3 and RAID 5, the primary consideration in selecting one or the other is the comparative performance capabilities. Video servers operate in real-time environments. As a result, the performance of a RAID under all operating conditions is the crucial consideration. While it is important to consider the performance of a RAID during normal operations, when all drives are functional, it is equally important to consider the performance of a RAID after a single drive has failed — also a normal operating condition. This consideration is required because a video server is typically guaranteed to deliver a minimum level of performance under all operating conditions. Therefore, the lowest performance capability of the RAID under any operating situation it may encounter is the specification that dictates the server's specified performance.

Performance with all drives operating

Because one drive in a RAID 3 is dedicated to redundancy, it cannot contribute to data transfer performance. However, the remaining drives are used for data operations. Because of RAID 3's parallel striping technique, the sustained transfer rate approaches the media limits of the data drives. For example, a RAID 3 in a 4+1 configuration (four data, one redundant drive) will have a sustained transfer rate approximately equal to four times the sustained transfer rate of an individual drive. In general, for an n drive RAID 3, the total number of streams supported is equivalent to n-1 drives, with adequately large data requests.

The analysis for a RAID 5 is a bit different. RAID 5 distributes redundancy information across all n drives. Furthermore, each drive is accessed individually. This enables each of the drives to service a data request simultaneously (providing the data requests are evenly distributed and there are no hot spots — a significant presumption). As a result, a RAID 5 theoretically can support n drives worth of streams.

In practice, RAID 3s track theory much better than RAID 5. This is due to the unpredictability of the request distribution. With a RAID 3, all requests access all drives, in parallel. This results in predictable performance. With RAID 5, however, any request distribution pattern that doesn't keep all the drives busy results in performance degradation. RAID 5 performance is much more difficult, if not impossible, to model accurately for a real-time environment. Many RAID 5 users find performance to actually benchmark at or below the n-1 level.

Performance after a drive fails

The strength of RAID 3 is its performance after a drive fails. In fact, there is no performance degradation after a drive has been removed from a RAID 3 array. These arrays perform data striping on-the-fly, using special hardware. The information stored on the redundant disk is also generated on-the-fly, using hardware. Because every piece of user data is striped on all drives, all operations occur in parallel. If a drive fails, a RAID 3 controller turns on hardware that regenerates the missing drive's data by combining the data from the remaining data drives and the redundancy drive. The hardware that performs this function typically is in the controller's data path. These cir-

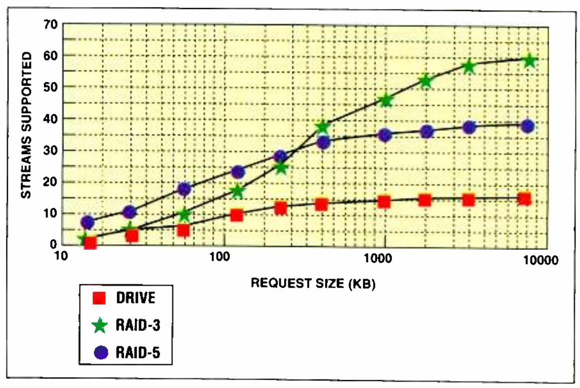

Figure 4. RAID performance after a drive failure in a multidisk array.

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RAID 5, on the other hand, has a significant performance degradation after a drive fails. It is RAID 5's strength, independent access to each drive, which causes the severe performance loss after drive failures. When a RAID 5 drive fails, the remaining drives must be accessed for every request of the failed drive. This, in turn, prevents the functional drives from servicing their own requests. To quantify the performance loss, something called the Array To Drive Request Ratio (A_D) must be examined.

The A_D is simply the ratio of the total number of array requests to the total number of disk requests required to complete the array request. In other words, an array request is simply a data request from the host. The drive requests are the actual disk operations inside the RAID 5 array to carry out a host request.

When all drives are operating, the A_D is one, because every

> The performance of a RAID under all operating conditions is crucial.

host request corresponds to exactly one disk request. However, after a drive has failed, there are far more disk requests (accesses) than host requests. Assume an even distribution of requests to all n drives, from the host's perspective. After a drive fails, n-1 of the n requests will be for the remaining n-1 functional drives. One of the n requests will be for the failed drive. The total array requests equal n-1 (for the good drives) +1 (for the failed drive) which equals n.

For the drive requests, the n-1 requests for the functional drives will correspond to n-1 drive requests, because each functional drive can perform one request. For a request to the failed drive, another n-1 request is generated, because all of the functional drives are used to regenerate the failed drive's data. In total, after a drive has failed, a RAID 5 will generate n-1 (for the good drives) + n-1 (for the failed drive) drive requests, or, more simply, 2*(n-1) drive requests. Hence, the ratio of host requests to drive requests (A_D) becomes n/(2*(n-1)).

To complete the analysis, the A_D is factored with the number of drives in a RAID 5 after a drive failure and the number of streams an individual drive can support. In general, the number of streams a RAID 5 will support is the product of the array to disk ratio, the number of usable drives in the array, and the number of streams supported per drive. Algebraically, total streams = A_D number of drives * S. Substituting the expression for A_D and n-1 for the total number of drives in a RAID 5 array after a drive failure, the

RAID disk arrays of video servers

total streams supported = n/(2*(n-1))*(n-1)*S. Simplifying, the total streams supported = n/2*S. Hence, the performance of a RAID 5 after a drive failure is only 50% of its theoretical maximum when all drives are operating. Figure 4 compares the performance of RAID 3 and RAID 5 after a single drive failure.

Subsystem redundancy

In addition to providing high levels of performance under all operating conditions, RAID 3 implementations can also provide redundancy features that are extremely useful in on-air broadcast environments. To ensure reliability, the power supplies and cooling fans (if used) should also be redundant, because they are the two most likely components for failure, after the disk drives. Redundant components should be hot-swappable after a failure. Hot swap is the capability to allow a failed component to be removed and replaced with a new unit without shutting down the subsystem. It is crucial for any redundant component in a real-time environment to support hot swap. Without such a capability, the subsystem must be shut down to service a failed component. During such times the video server would no longer be able to operate at full capacity, if at all. With hot swap, a failed component can be replaced and the subsystem brought up to 100% protection without a user ever knowing the service has been performed.

The converging worlds of video production, broadcast, communications and computing are placing an ever-increasing burden on the architects of video servers. These architects must design systems that deliver many streams of video, in real-time, and for a price that is palatable. The storage component of the video server accounts for about 50% of the total system cost and is a key performance component. It is for these reasons that RAID disk arrays have become an integral part of video server architectures.

RAID 1, or mirroring, duplicates every drive. Compared to alternative RAID architectures, this approach is not cost-effective. Furthermore, the decreased reliability of a large number of spindles and the complexities of packaging, powering and cooling a RAID 1 implementation is prohibitive.

RAID 3 and RAID 5 stripe user data and only require a single drive's worth of capacity for redundancy. They differentiate themselves in performance. While, in theory, RAID 5 may have a slight performance advantage when all drives are operating, in practice this is not often realized. But the main difference in these two RAID architectures is the performance after a drive fails. While RAID 3 doesn't experience any performance degradation, the RAID 5's performance will drop by 50%. For the real-time environments of video servers, it is RAID 3's robust performance, over all operating conditions, that makes it an ideal choice.

Bill Moren is a senior product manager for Ciprico Inc., Plymouth, MN.

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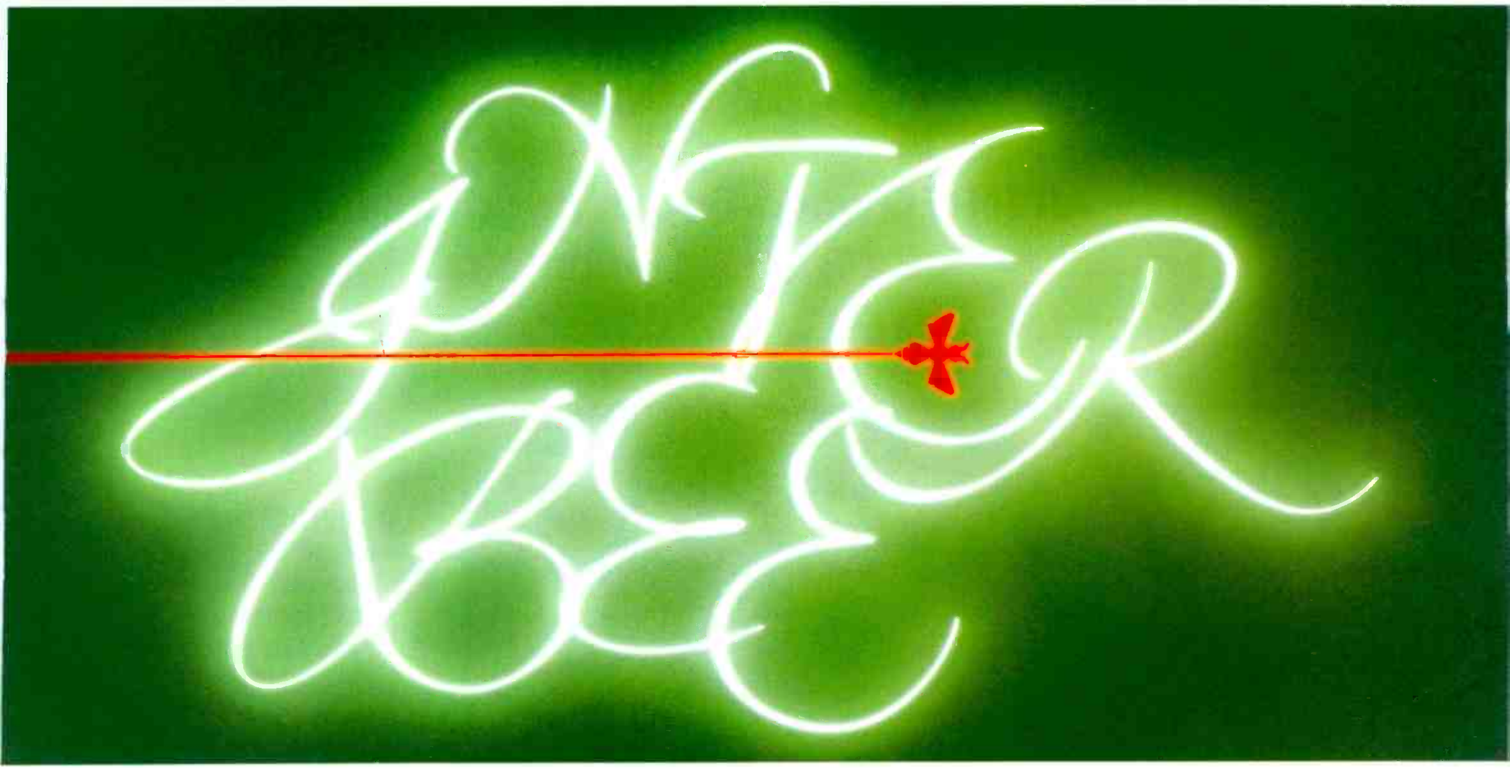

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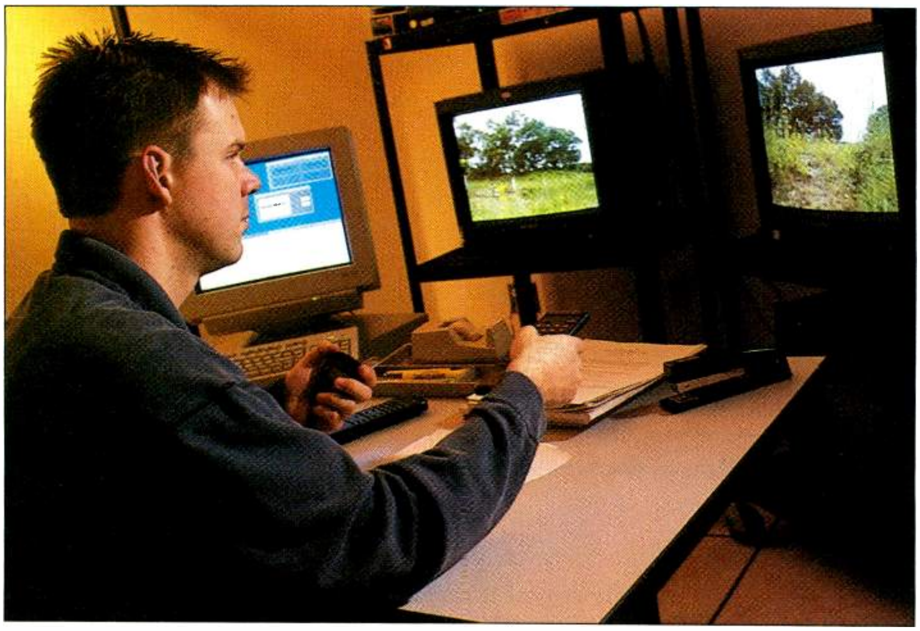
MPEG encoding: The secret to quality compression

All MPEG encoding is not the same.

By Richard Schmeltz



THE BOTTOM LINE:
Quality MPEG encoding can be costly. Doing it yourself requires a significant investment in hardware and personnel. Taking the job out-of-house has certain advantages, but does it make sense for your facility? Understanding the entire encoding process can make the choice easier. $

Two years ago, work on Bell Atlantic's video dial-tone trials was getting under way. In researching the project, it was determined that most MPEG service providers were limited in the number of minutes of material they could handle on a monthly basis. If pressed to do more, the quality of the encoded product began to suffer. Because of this, Bell Atlantic created the TELE-TV Systems' Digital Service Bureau (DSB) to handle all of its encoding (compression) needs. Using a modular facility architecture, the facility can now encode large amounts of video data without the time vs. quality trade-offs typical of other facilities. This article details the various

Non real-time encoding requires human intervention at every stage, and delivers higher quality video at much lower data rates. (Photography by Adam B. Auel.)

steps involved in the MPEG encoding process and should make it easier to decide whether to do your facility's MPEG encoding yourself or to send it out of house to a service bureau.

The digital encoding industry is growing as service providers, including broadcasters and cable companies, realize the benefits of digital compression. Encoding can help streamline broadcast operations and squeeze more channels into the same spectrum space, thereby reducing delivery costs. Also, new developments in MMDS technology have escalated the demand for digital content. Telephone and other utility companies are moving rapidly to establish digital TV and business communication services in order to compete with cable and broadcast in this relatively new marketplace. To stay ahead, many traditional providers are beginning to convert their existing video archives for more cost-effective transmission and/or storage through digital encoding technology. To ensure a quality encoding, what goes on before and after the encoding session is just as important as the session itself.

> Manufacturers of server, transport and set-top box technology have varied widely in their interpretation and implementation of MPEG-compliant components.

Why digital encoding?

Digital compression allows programmers to deliver more than 100 digital channels in the same spectrum space required to transmit 33 analog channels. Digital transmission also typically provides improved picture clarity and sound quality, thereby heightening the digital providers' edge over traditional analog services. Furthermore, content

MPEG encoding: The secret to quality compression

stored and transmitted in compressed digital form results in a much more stable, predictable product than identical content stored on traditional videotape. Analog tape is affected by the ravages of age, poor environmental control, physical damage, generational loss and analog transport errors. The effects show up as visual and/or audible defects that increase over time and distance.

The Moving Picture Experts Group (MPEG)) compression standard, which includes MPEG-1 and MPEG-2, is the most widely accepted compression standard in the industry. MPEG encoding uses predictive calculation, evaluating what happened in previous frames and predicting where pixel differences (movement) will occur in succeeding frames. The differences are encoded, maintaining smooth motion between frames.

Under the MPEG umbrella are two methods of digital encoding: real-time and non-real-time. Real-time digital encoding results in higher data rates and eliminates human intervention from the process. The encoding engineer in this scenario has little input in the process as the content moves through the encoding equipment to the transmission system. Picture quality is determined by the quality of the source signal, encoding and delivery equipment, the network transport mechanism and the receiver. The non-real-time method achieves high-quality video at lower data rates. Non-real-time encoding requires skilled human intervention at every step in the process.

> It is often necessary to find a "work-around" solution when constraints are mutually exclusive.

The final picture quality determinant is not just a case of hardware — it is dramatically affected by the skill of the encoding engineer. The net result of using non-real-time encoding is high-quality video at significantly lower data rates than are possible in the real-time scenario.

TELE-TV Systems' Digital Service Bureau pioneered the approach of assigning a craftsman (the new industry term is "compressionist") to each encoding project. The practice is called expert-assisted encoding, and it means that a highly skilled compression engineer controls every phase of the encoding process from start to finish, ensuring a rigorous quality-control standard. For each project, the engineer selects project-specific tools and parameters, controls the entire encoding process and personally monitors the results.

What's involved

The encoding process begins when the client or potential client walks in the front door with a request. Many clients want their content digitally encoded to support near video-on-demand (NVOD) and VOD applications. Unfortunately, although they all want MPEG-encoded material, their systems may not all comply with the same MPEG parameters. Significant variations exist among clients and projects. This is why it is important for your service bureau to be able to provide a broad range of features and options. Manufacturers of server, transport and set-top box technology have varied widely in their interpretation and implementation of MPEG-compliant components. Digital compression engineers faced with conflicting MPEG requirements and constraints often lament the irony of the statement: "MPEG is MPEG, unless it's MPEG."

The first step in ensuring a quality MPEG-encoded product is high-quality source material; consequently, a large

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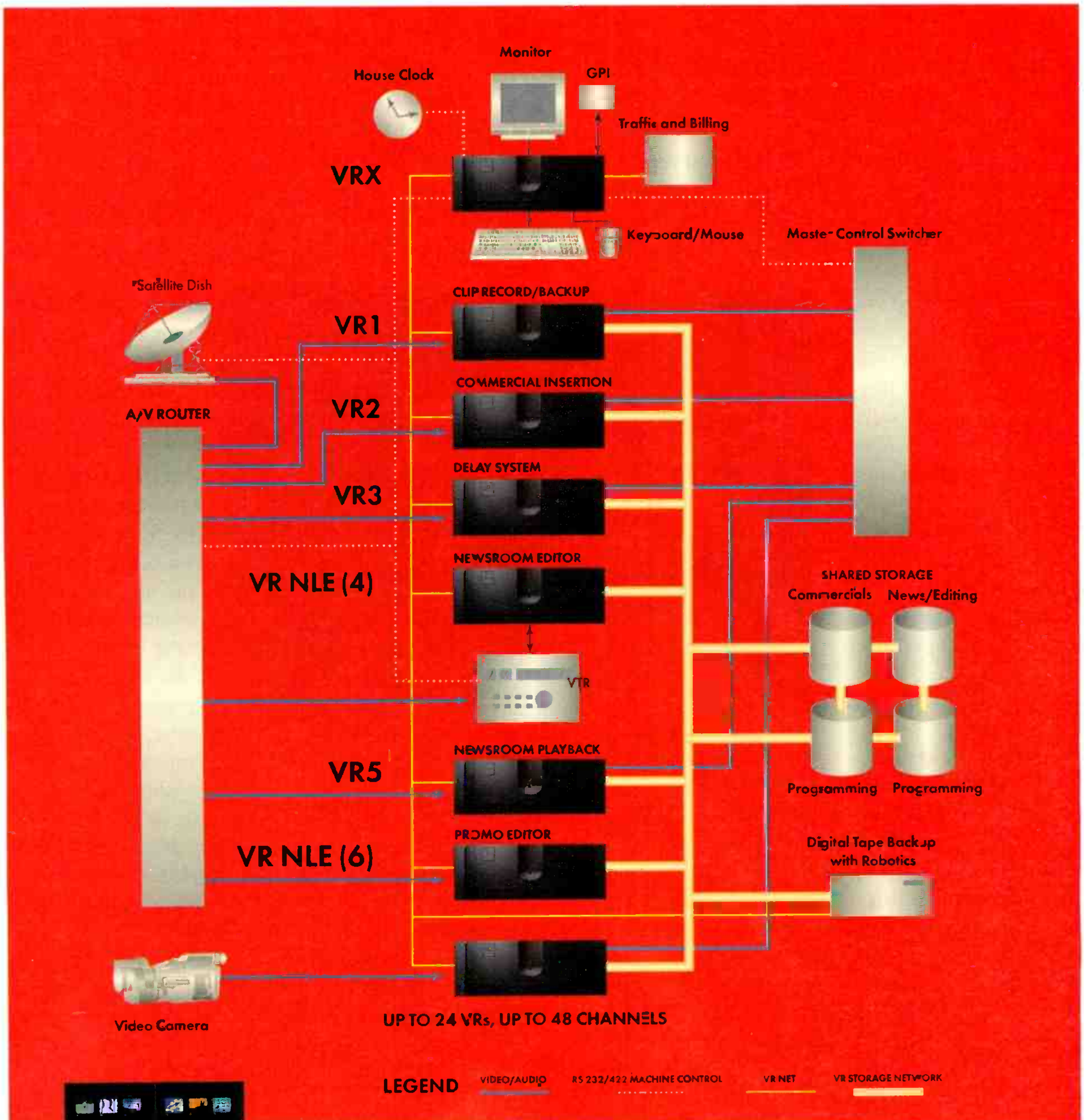
WHY TOTAL REDUNDANCY?



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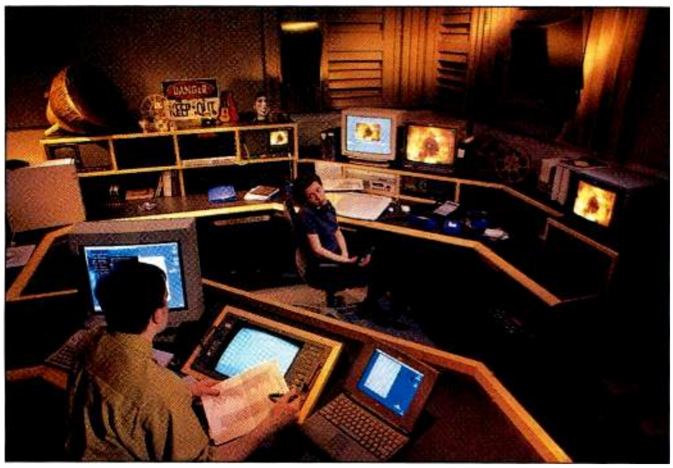
MPEG encoding: The secret to quality compression

amount of time should be spent evaluating the source material. The evaluation often takes as long as the actual encoding itself. It includes objective and subjective evaluations, such as basic measurements of audio and video levels, checks for contiguous time code, "mapping" any non-program material (i.e., black segments for commercial breaks) that may need to be removed during the encode process, and searching for media defects and/or production flaws. In our case, less than 5% of all incoming material is found to be problematic. Only a small part of the initial source evaluation is dedicated to "weeding out" material unacceptable for encoding. The bulk of the analysis centers on identifying which encoding parameters and tools will best complete a particular project.

Tailoring MPEG video to a particular environment requires a significant investment of time and resources. Service bureaus must research each project for every new customer. The encoding facility soliciting information must understand constraints involved and special factors unique to their MPEG implementations. Also, it is important that specific file format requirements of the server(s) be known. A service bureau should evaluate all the constraints and factors on a project-wide basis to determine a specific solution for that particular component mix. It is often necessary to find a "work-around" solution when constraints are mutually exclusive. This is where a knowledgeable service bureau becomes especially important.



TELE-TV Systems' Digital Service Bureau pioneeered expert-assisted encoding. Each project is assigned a skilled craftsman who controls the encoding process from start to finish. (Photography by Robert Rathe.)

The DSB approach

The Digital Service Bureau found that to maximize efficiency and ensure the highest quality output, it was necessary to develop a custom toolkit of software and hardware resources. The toolkit is literally a set of previously identified workable solutions that are applied when appropriate. The toolkit grows as new solutions are developed. Engineers use the toolkit to tailor the encoding process on a project-by-project and often scene-by-scene basis to optimize quality.

After encoding, every title undergoes a linear review by the quality control team. We firmly believe that, although several products on the market claim to perform objective quality analysis, the best means of quality evaluation today is still the human eye. It is important to note that the encoded content must be evaluated in an environment that emulates the actual target system and viewing conditions as closely as possible. The team ultimately decides whether an encoded title passes muster. If necessary, it has the authority to bounce back content to be re-encoded.

Ensuring quality

Quality of the source material is always the major determinant of the finished encoded product. The garbage in, garbage out cliche is a truism in relation to MPEG as it is nowhere else. Regardless of the tools and engineering skills, a poor-quality source will preclude the production of an optimal-quality MPEG image stream. The best encoding engineer can only overcome source flaws to the limit of the current technology.

Source content ranges from new releases to archival material. The quality of archival material varies widely. Content issues begin with the physical integrity of the cassette or reel, from a broken casing to rolls or creases in the tape itself. Resulting video degradation is evidenced in hair lines, snow and faded color.

Another key determinant of final product quality is the encoding engineer's training. The engineer makes crucial decisions before, during and after the encoding process. The ability to make the right choices is key to producing a quality encoded product. The engineer must be able to decide which material is acceptable to encode, what elements in the source material to preserve and what to delete as defects and, finally, what is an acceptable encoded product and what is not. In addition, most clients require the encoded product to look exactly like the original material, with no color correction or audio adjustment. The initial source evaluation is important in these cases because the digitization process picks up everything on the tape, and clients need to know exactly what will be recorded.

As you can see, there is far more to quality encoding than simply running the footage through the proper equipment. Getting a high-quality encoding that maximizes the bandwidth available is critical to using compression effectively. Too few bits adversely affect quality, while too many bits waste valuable bandwidth. Because more bandwidth costs more money, it makes economic sense to use it as effectively as possible. ■

Richard Schmeltz is the managing director at TELE-TV Systems' Digital Service Bureau, Reston, VA.

FOR MORE information
Call 888-2 ENCODE or circle (202) on Action Card.

Optics 101: What you really should know about lenses

We all remember the basic principles of optics, don't we? Yea, sure we do.

By Jerry Whitaker

THE BOTTOM LINE:
Images "seen" by a camera must first pass through the lens. Distortions caused by the lens become a permanent part of the image. Today's lens assemblies use a variety of techniques, from aspherical elements to hi-tech coatings to provide high-quality images with minimal distortion. A basic understanding of lens theory combined with a sharp eye can help determine minor differences between lenses. Once those differences are identified, choosing the right lens is easier. $

Choosing a lens for studio production might at first glance appear to be a straightforward task. However, all types of cameras, from ENG to high-end production models, are used in studios, and each one is served by specific types of lenses. Although this complicates the selection process, a good understanding of the available choices can make the selection considerably easier. And a firm grasp of the physical properties that make lenses work is a big plus too. The latter is the focus of this article. Although we probably studied geometric optics in college, that has been — I'll wager — more than a few years ago. A refresher course is probably in order.

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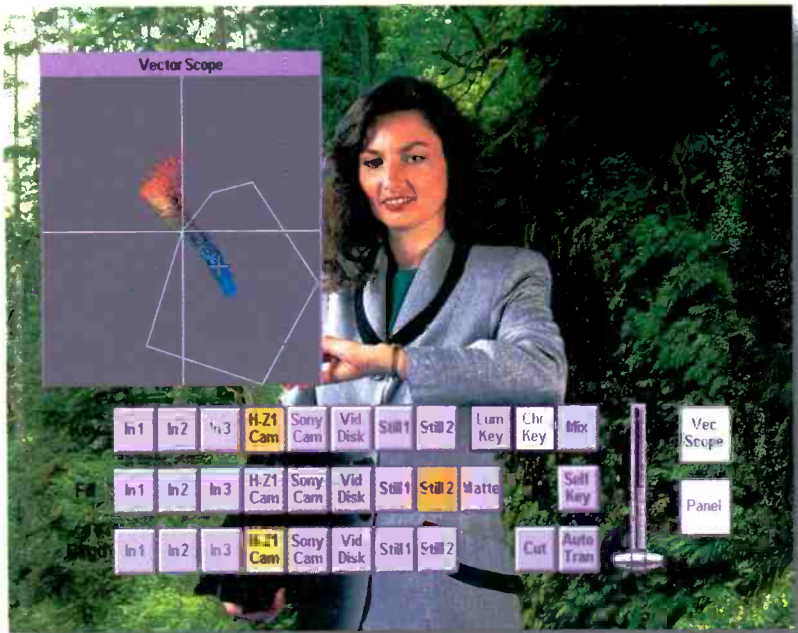

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Optics 101: What you really should know about lenses

Geometric optics

Geometric optics is the branch of optics that deals with image formation using geometric methods. It is based on two postulates:

1. Light travels in straight lines in a homogeneous medium.
2. Two rays may intersect without affecting the subsequent path of either.

The fundamental laws of geometric optics may be developed from general principles, such as Maxwell's electromagnetic equations or Fermat's principle of least time. However, the laws of reflection and refraction can also be determined in a simple way by *Huygen's principle*. This principle states that every point of a wave front may be considered as a source of small waves that spread out in all directions from their centers to form the new wave front along their envelope.

The laws of reflection and refraction for optics may be stated as follows:

- *Law of Reflection*: The angle of the reflected ray is equal to the angle of the incident ray.
- *Law of Refraction*: A ray entering a medium in which the velocity of light is different is refracted so that $n \sin i = n' \sin r$, where i is the angle of incidence, r is the angle of refraction and n and n' are the indexes of refraction of the two media.

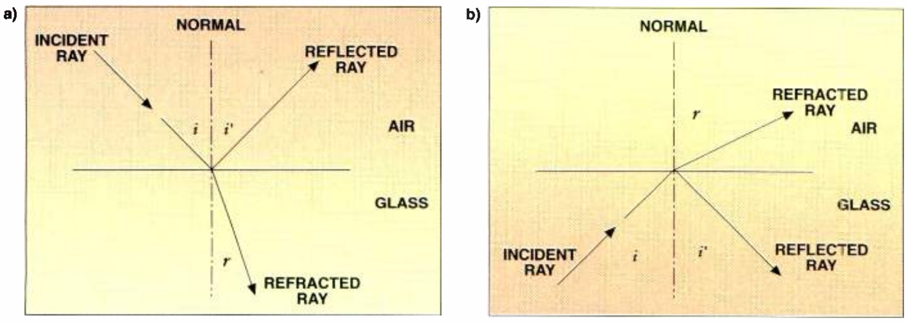


Figure 1. Refraction and reflection at the air-glass surface: *a)* beam incident upon glass from air, *b)* beam incident upon air from glass.

A *ray* is an imaginary line *normal* to the wave front. The angle the advancing ray forms with the line normal to the surface in question is the *angle of incidence* and is equal to the angle the wave front forms with the surface.

The *index of refraction* is the ratio of the velocity of light c in a vacuum to the velocity v in the medium:

$$n = c / v \qquad n' = c / v'$$

For air, the velocity of light is generally considered equal to the velocity in vacuo, so n= 1 and the equation may be simplified to:

$$\sin i / \sin r = n'$$

When a ray passes from a medium of smaller index into one of larger index, as from air to glass, the angle of refraction is less than the angle of incidence and the ray is bent toward the normal. In passing from glass to air, the ray is bent away from the normal, as illustrated in Figure 1. The incident ray, reflected ray, refracted ray and the normal to the surface at the point of incidence all lie in the same plane.

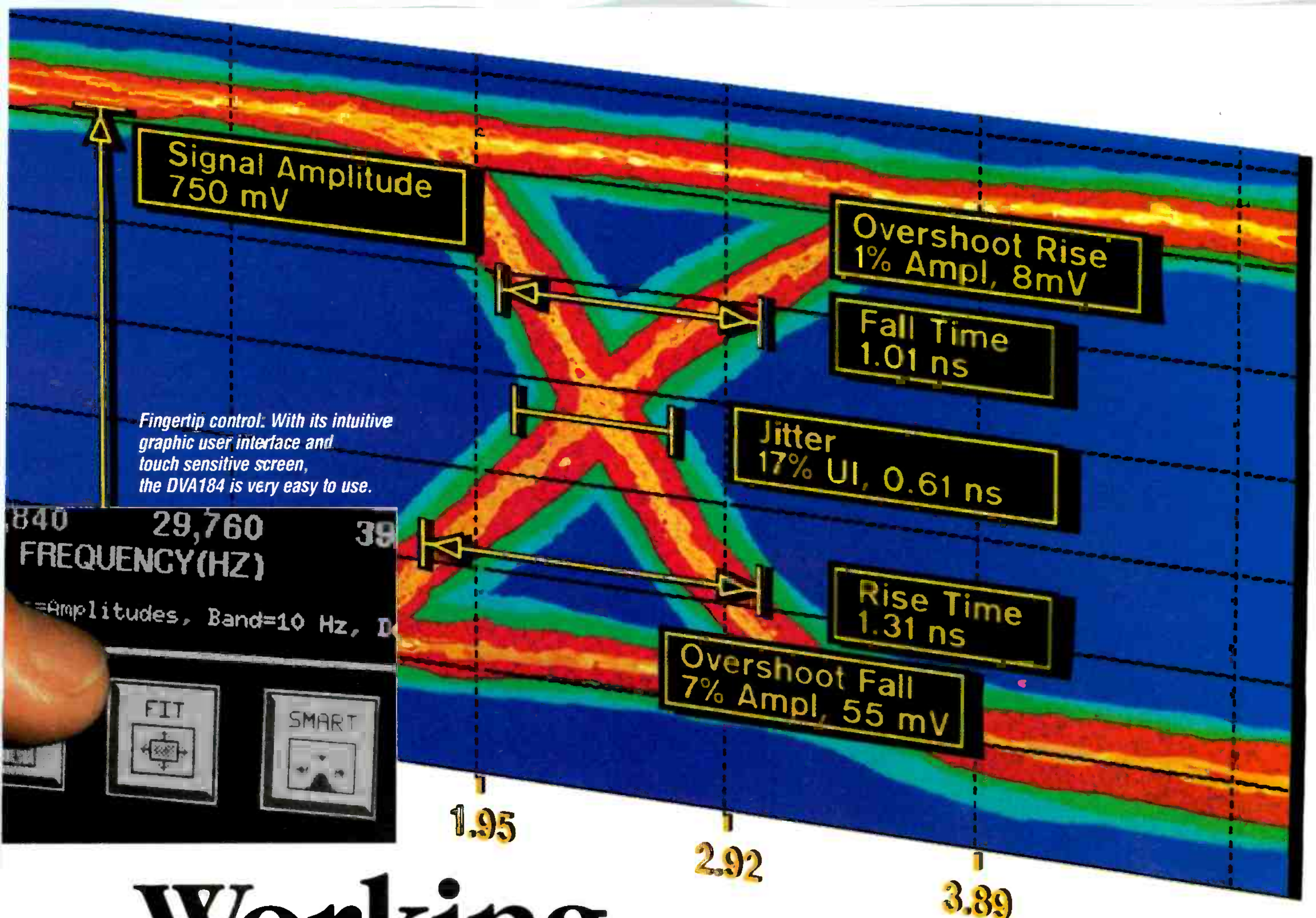
A ray passing from a medium of higher index to one of lower index may be totally internally reflected. The following relationship applies:

$$n \sin i = n' \sin r$$

The value of sin r is always greater than sin i when n is greater than n'. The maximum value for sin r is unity (r=90°) and occurs for some value of i, called the *critical angle*, which is determined by the refractive indexes of the two media.

When the angle of incidence exceeds the critical angle, the ray is not refracted into the medium of lower index, but is totally reflected, as illustrated in Figure 2. For angles smaller than the critical angle the rays are partially reflected.

Application of the *sine law* to two parallel surfaces, such as a glass plate, shows that the ray emerges parallel to the entering ray, but is displaced. The most important applications of the laws



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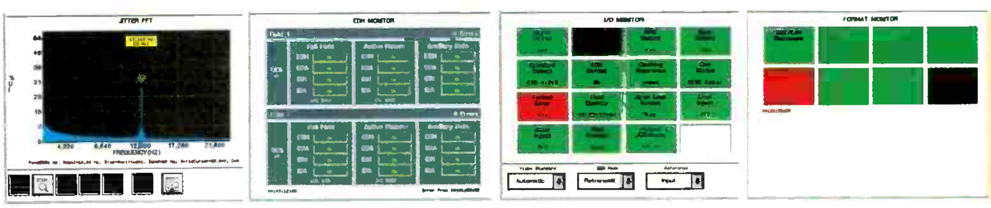

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Optics 101: What you really should know about lenses

of reflection and refraction relate to the formation of images by means of spherical surfaces, such as mirrors and lenses.

Refraction at a spherical surface in a thin lens

It can be shown by tracing a ray through a single refracting surface that:

$$\frac{n}{s}+\frac{n'}{s'}=\frac{n'-n}{R}$$

Where s=the object distance to the refracting surface, s′=the image distance to the refracting surface, R=the radius of curvature of the surface, n=the index of refraction of the object medium and n′=the index of refraction of the image medium.

A ray traversing two refractive surfaces, as in a lens in air, has a path whose image distance and object distance are found by applying the foregoing equation to each of the two surfaces. For a lens whose thickness may be considered negligible relative to the image distance, the following applies:

$$\frac{1}{s}+\frac{1}{s'}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

Where n=the index of refraction of the lens, R1=the radii of curvature of the first surface, R2=the radii of curvature of the second surface. The right side of the equation contains quantities that are characteristic of the lens, called the *power* of the lens. The reciprocal of this expression is the *focal length*, f:

$$\frac{1}{f}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$$

For a thin lens in air the object distance, image distance and focal length are related as follows:

$$\frac{1}{s}+\frac{1}{s'}=\frac{1}{f}$$

Certain conventions of algebraic sign must be observed in the use of this and previous equations. The conventions may be summarized as follows:

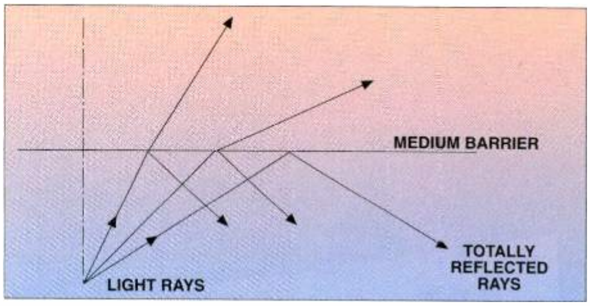

Figure 2. The result when the angle of refraction exceeds the critical angle and the ray is totally reflected.

- All figures are drawn with the light incident on the reflecting or refracting surface from the left.
- The object distance s is considered positive where the object lies at the left of the *vertex*. The vertex is the intersection of the reflecting or refracting surface with the axis through the center of curvature of the surface.
- The image distance s′ is considered positive when the image lies at the right of the vertex.
- The radii of curvature is considered positive when the center of curvature lies at the right of the vertex.
- Angles are considered positive when the slope of the ray with respect to the axis is positive.
- Dimensions, such as image height, are considered positive when measured upward from the axis.

In general, after observing the first two conventions, the others follow the rules of coordinate geometry with the vertex as the origin.

From the previous equations and the foregoing sign conventions it is apparent that the sign of the focal length may be negative or positive. For a lens in air, and parallel incident rays, the focal length is positive when the transmitted rays converge and negative when they diverge. Cross sections of simple converging and diverging lenses are shown in Figure 3.

There are two focal points of a lens, located on the lens axis. All incident rays parallel to the lens axis are refracted to pass through the second focal

Optics 101: What you really should know about lenses

point; all incident rays from the first focal point emerge parallel to the lens axis, as illustrated in Figure 4. For a thin lens, the distances from the two focal points to the lens are equal and denote the focal length.

The magnification m provided by a lens is defined as the ratio of the image height y′ to the object height y:

$$m = y' / y$$

The principles of magnification are illustrated in Figure 5. From the similar triangles ABC and EDC, it follows:

$$m = \frac{y'}{y} = -\frac{s'}{s}$$

Thick (compound) lenses

The equations given previously apply to thin lenses. When the thickness of the lens cannot be ignored, measurements must be made from reference points other than the lens surface, such as the focal points — which have already been defined — or from the *principal points*. The principal points are located as follows. (See Figure 6.)

- Consider ray OA proceeding from the object parallel to the lens axis. This will be refracted to pass through the focal point F′.
- The ray OB, which passes through the focal point F, will emerge along DI parallel to the lens axis.
- If OA and F′I are extended, their point of intersection lies in the second principal plane.
- The point H′, where this plane intersects the axis, is called the *second principal point.* Similarly, the intersection of OF and DI extended lies in the first principal plane, and H is the *first principal point*. The distances FH and F′H′ are the first and second focal lengths, respectively.

When the index of the medium on both sides of the lens is the same, as for a lens in air, the first and second focal lengths are equal.

If the direction of the light ray is reversed (the object is placed at the image position), the ray retraces its path and the image is formed at the former object position. Any two corresponding object and image points are said to be conjugate to each other, and hence are *conjugate points.*

The equation

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

given for a thin lens continues to hold for a thick lens, but s and s′ are measured from their respective principal points, as is the focal length f. The object distance, image distance and focal length are related in another form, known as the *Newtonian form* of the lens equation. If x is the distance of the object from its focal point, and x′ the image distance from its focal point, then:

$$\chi \times \chi' = f^2$$

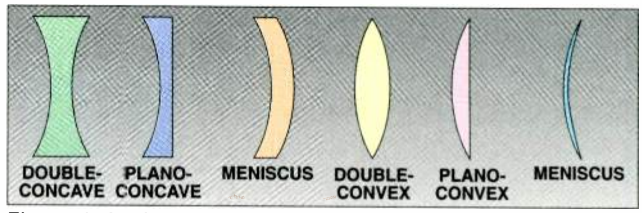

Figure 3. Various forms of simple converging and diverging lenses.

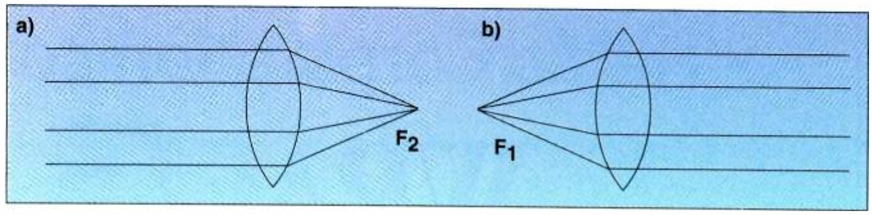

Figure 4. Lens effects: *a)* parallel rays incident upon the lens pass through the second focal point, *b)* rays passing through the first focal point incident upon the lens emerge parallel.

Lens aberrations

Up to this point, optical images have been considered to be faithful reproductions of the object. The equations given have been derived from the general expressions for the refraction of a ray at a spherical surface when the angle between the ray and the axis is small so that sin θ=θ. This approximation is known as *first-order theory*. The departures of the actual image from the predictions of first-order theory are *aberrations.*

Von Seidel extended the first-order theory by including the third-order terms of the expanded sine function. The *third-order theory* contains five terms to be applied to the first-order theory. When no aberrations are present, and monochromatic light is passed through the optical system, the sum of the five terms is zero. Thus, von Seidel's

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Optics 101: What you really should know about lenses

sums provide a logical classification for the five monochromatic aberrations. In addition, two forms of chromatic aberration can occur because of variation of index with wavelength. The five monochromatic aberrations are:

1. Spherical aberration;
2. Coma;
3. Astigmatism;
4. Curvature of field; and
5. Distortion of field.

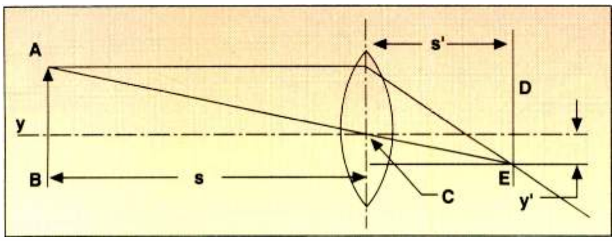

Figure 5. Magnification of a simple lens.

Spherical aberration may be described as the failure of rays from an axial point to form a point image in the direction along the axis. In general, spherical aberration can be minimized if the deviation of the rays is equally divided between the front and rear surfaces of the lens. In a system of two or more lenses, spherical aberration can be eliminated by making the contribution of the negative elements equal and opposite to that of the positive elements.

Coma relates to failure of the rays from an off-axis point to converge at the same point in the plane perpendicular to the axis. Coma can be eliminated for a given object and image distance in a single lens by proper choice of radii of curvature.

Astigmatism contains aspects of both spherical aberration and coma. It resembles coma in that the off-axis points are affected, but — like spherical aberration — results from spreading of the image in a direction along the axis. The rays from a point converge on the other side of the lens to form a *line image*, actually the axis of a degenerate ellipse; continuing, the rays join with other rays to form a circle, and then at a still further distance form a second image crossed perpendicularly to the first.

The best focus occurs when a circular image is formed. The locus of inner line images — the primary images — is a surface of revolution about the lens axis, called the *primary image surface*, shown in Figure 7. The locus of outer line images forms the secondary image surface. The locus of *circles of least confusion* forms the *surface of best focus*. As shown in the figure, these surfaces are tangent to one another at the lens axis. Astigmatism is the failure of the primary and secondary image surfaces to coincide. The surface of best focus is usually not a plane but a curved surface; this type of aberration is known as *curvature of field*. It is not possible to eliminate astigmatism and curvature of field in a single lens.

All rays passing through a lens from the center to the edge should result in equal magnification of the image. Distortion of the image occurs when the magnification varies with axial distance. If the magnification increases with axial distance, the effect is known as *pincushion distortion* and the opposite effect is *barrel distortion*.

The five types of lens aberration described in this section can occur in uncorrected lenses even though light of a single wavelength forms the image. When the image is formed by light from different regions of the spectrum, two types of chromatic aberration can occur:

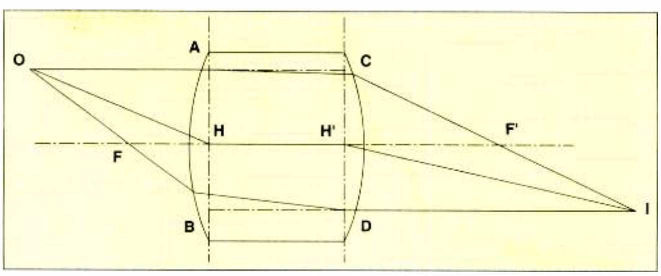

Figure 6. Focal points and principal planes for a thick lens.

1. *Axial* or *longitudinal chromatism;*
2. *Lateral chromatism.*

Axial chromatism results from convergence of rays of different wavelength at different points along the axis; the lens focal length varies with wavelength. Because magnification depends upon the focal length, the images are also of different size, producing lateral chromatism. In many instances, lenses are corrected so that the focal points coincide for two or three colors, thus eliminating longitudinal chromatism. However, unless the focal lengths are also made to coincide, the images will be of slightly different size. This defect results in color fringing in the outer portions of the field.

These optical distortions will be familiar to video engineers who have dealt with such aberrations in pickup and display systems for many years.

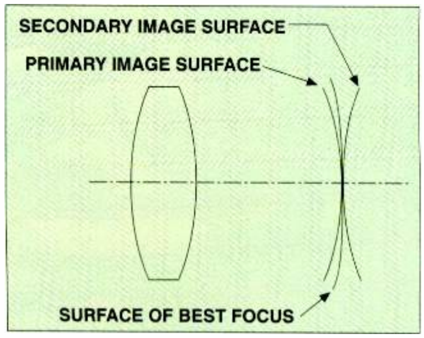

Figure 7. Surfaces of best focus, illustrating lens astigmatism.

For further information

In this article, we have only scratched the surface (forgive the pun) of lens technology. In the process, however, we have laid a firm foundation for further study on the subject, and helped engineers understand the many trade-offs that exist in lens design and application. See below for additional information on this subject. ■

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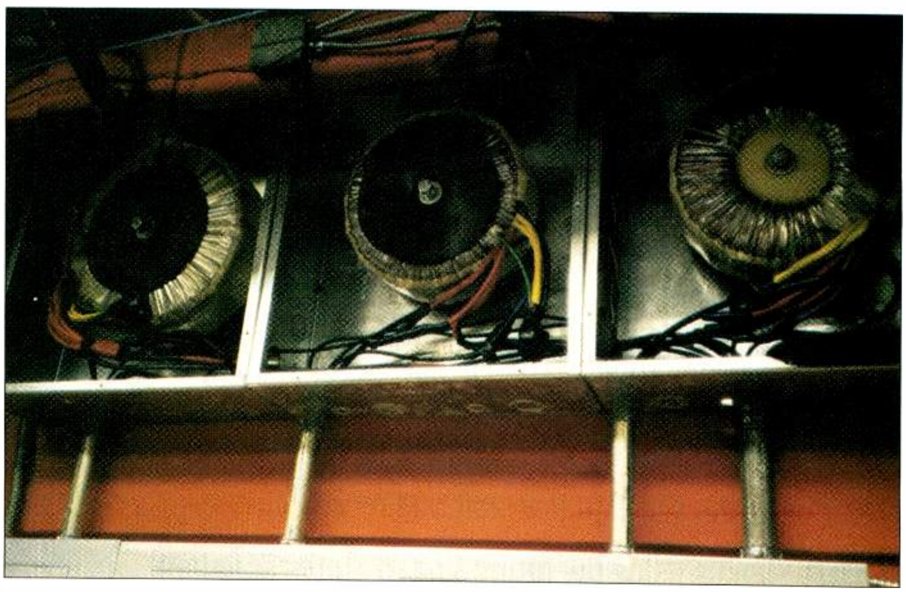
Jerry Whitaker is a Broadcast Engineering *consulting editor.*

An unconventional approach to power and grounding

Finding and keeping clean power may have just gotten easier.

By Eric Wenocur



THE BOTTOM LINE:
Final production quality is basic to nearly all facilities. Clean audio and video signals are a must. Clean power and proper grounding are essential. Ground problems, however, seem to have plagued facilities since day one. Eliminating these problems can be expensive, time-consuming and a waste of valuable resources. By preventing ground and hum problems in the early stages of design and construction, engineers can concentrate resources on other issues. $

Over the years, certain aspects of facility power and grounding have become well-accepted. In particular, single-point grounding techniques have dominated as the best way to create a "clean" technical power system. The objective is to reduce hum, buzz and radio frequency (RFI) components on power and signal grounds, thus reducing noise impressed on audio and video signals.

Recently, however, there have been stirrings around the TV and audio recording industries suggesting other approaches to solving noise issues. Articles and seminars have dealt with the sources of

The three toroidal transformers are mounted in enclosures located near the electrical panels and provide balanced power, as well as some isolation from externally generated noise and spikes.

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Jim Moriarty, General Manager, YES Productions, New Orleans, LA., commenting on the purchase of new HK-366 and HL-57 cameras.

"When we decided to make our fifteen-year-old truck brand new, we reviewed all the cameras available and decided to stay with an old friend. Ikegami's HK-366 was a camera we've had our eyes on for some time.

The HK-366/HL-57 cameras have the Skin Tone Detail feature which received the Engineering Emmy Award for technical achievement.

Ikegami cameras always seem to have a much warmer picture than the other cameras on the market. Our engineers favored the Skin Tone Detail feature which gives us the ability to lock on a skin hue without affecting the detail in the rest of the picture. Extra mic inputs, overall sensitivity, and colorimetry were other key features of the cameras. The MCP panel gives our engineers complete control to create the desired "look." Our EIC was ecstatic over the fact that the MCP memory cards give him each camera setup from scratch.

Our operators liked the PIP return video in the viewfinder, the 2-way trunking (which allows us to feed sources through the triax, i.e., a clock camera to the trunk and iso feeds out of the side of the camera), and the extra intercom features.

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An unconventional approach to power and grounding

noise, how noise gets into signal circuitry, and noise control through the use of balanced (symmetrical) AC power. My own experiences with conventional grounding techniques have been so unsatisfactory — in terms of failure to solve problems and difficulty in implementation — that I have chosen to try some unconventional, but theoretically sound, ideas in recent installations.

Noise sources

The noise problems familiar to audio and video engineers range from audible hum, buzz and interference at various frequencies to visible hum bars and RF moiré in video signals. Many of these can be traced to coupling of environmental noise into signal cabling, while other noise originates in the incoming power or in equipment itself.

One primary source of ground-related hum is voltage differentials between different points in the power system. This is the classic "ground loop" phenomenon; two points are at differing potentials, so current flows between them. In the case of broadcast systems, ground currents can arise from several sources; commonly these include leakage currents from line filters and transformers in equipment power supplies or devices that present an unbalanced load — that is, when some of the power delivered to the load leaves via a path other than the neutral, generally meaning the ground. Recalling Ohm's Law, a voltage drop occurs when current flows through some resistance. The resistance component is the impedance of the grounding conductors themselves.

A second minor source of noise is induction of AC hum into signal wiring. Any conductor carrying a current radiates magnetic and electrostatic fields that can induce current in a nearby conductor. The intensity of the induced current depends on the proximity of the two conductors, but even following good cable dress practices, such as keeping power and signal wires perpendicular to each other and using steel enclosures, there is enough AC field activity around equipment and signal wiring that this can be an issue. Even if your signal is carried in a shielded cable, a nearby AC field still induces current in the shield, thus becoming a source of ground differential voltage.

The typical solution for ground differential hum is to try creating a system in which all equipment is grounded via only one path: the power cord third pin. This requires isolating chassis from racks, using iso-ground power receptacles and lifting the shields of signal cables at one end. This last practice is absurdly difficult to maintain through patch fields and in systems with considerable unbalanced equipment, such as video facilities, where the ground conductor is also the signal return. Additionally, it makes the shields into appealing antennas for RF signals. In either case, ground-borne hum appears at the "earth ground" of equipment to which the shield is connected. This is typically the enclosure, or some part of the internal structure, which should be protecting the circuitry from noise. Instead, due to poor design, it allows the noise to be coupled inside of the enclosure (the so-

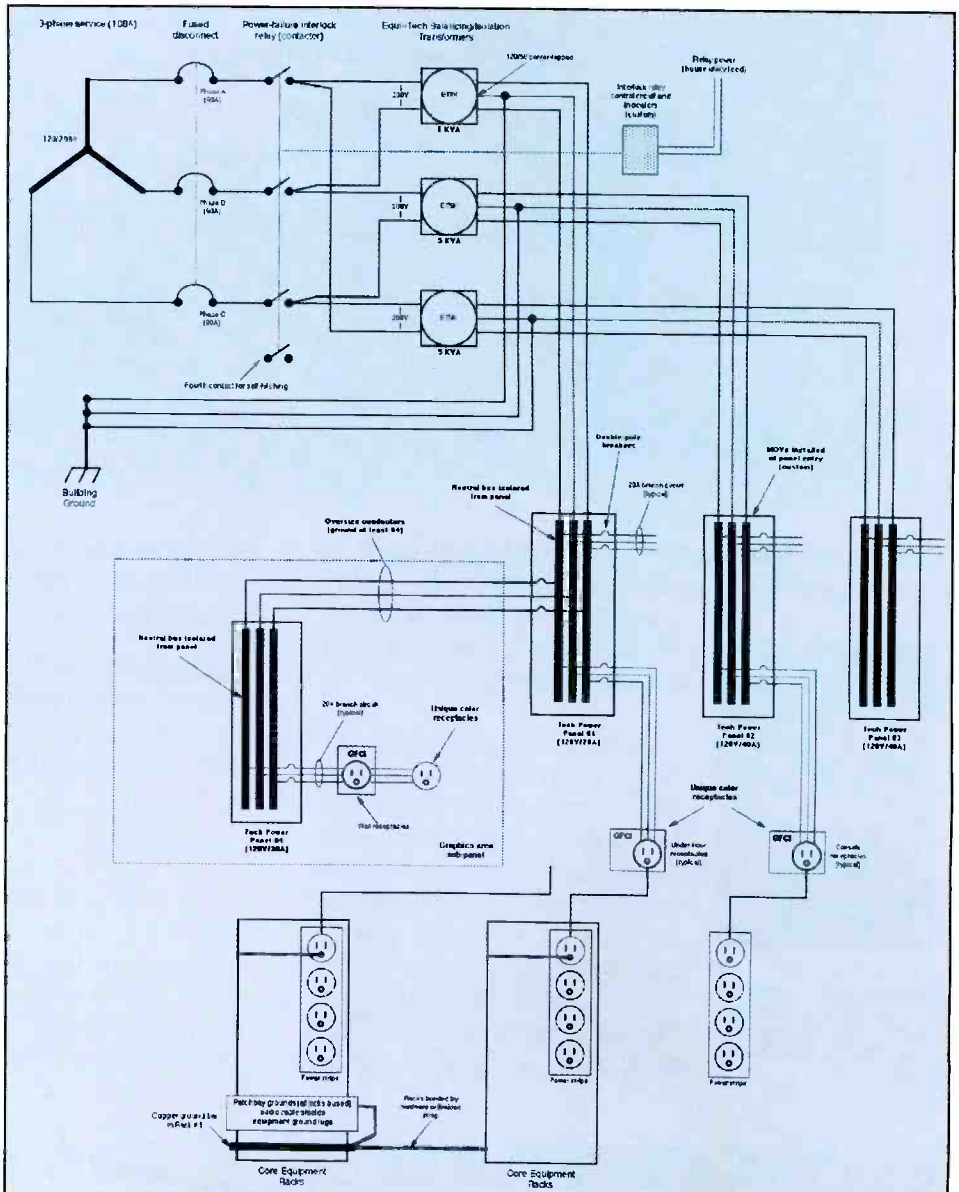

Figure 1. Conceptual block diagram of the grounding and balanced power system used at Fast Cuts, Inc., Washington, DC.

called "pin 1 problem"). This problem is so common it is shameful.

You can try bringing all your shields to some central "earth ground" point in the hope of bleeding off the ground noise, but the noise does not "flow into" the earth. This is a common fallacy. Aside from safety, ground rods (or bonds to building steel) help to equalize any voltage potential between the technical power and utility power grounds and reduce static charge buildup on shields, but they do not absorb ground noise. In the end, single-point grounding and heavy earth grounds are attempts to treat the symptoms of noise, but not the source problems.

An important point to remember is the value of transporting signals on pairs of conductors because of their inherent ability to cancel unwanted noise; if all equipment used balanced/differential floating inputs and balanced outputs, most ground noise issues would be moot. This applies to power signals as well; the hot and neutral conductors in a line cord carry equal and opposite currents that effectively cancel most radiated fields.

In the end, single-point grounding and heavy earth grounds are attempts to treat the symptoms of noise, but not the source problems.

Balanced AC power

The notion of balanced AC is not that new, it simply has been forgotten, particularly since modern electrical distribution (at 120V) relies on a single "hot" conductor and a grounded neutral. Balanced (symmetrical) power works much like balanced audio; there are two hot conductors each carrying the same AC voltage but 180° out of phase. In the case of typical electrical systems, this translates to two conductors at 60V relative to ground. The end result at the line cord is still 120V but there is no "neutral."

The primary advantage of this approach is that common-mode noise (which is equal and in-phase on both conductors) is nulled at the ground. Leakage currents in a power supply, particularly those from line filters (which are balanced by design), are summed and canceled at the ground conductor. In addition, distortion and noise caused by non-linear components in power supplies are also canceled. Switching power supplies, ubiquitous in today's equipment, tend to introduce more of this type of noise due to their lack of a large transformer at the power input acting as a low-pass filter.

Installing a balanced technical power system is only moderately different from conventional power. The most difficult part is getting electrical contractors to think differently: "balanced" does *not*

An unconventional approach to power and grounding

refer to balancing the loads on a three-phase service and *there is no neutral.* Electricians are so accustomed to neutral and ground being effectively the same that there is no telling what might get connected wrong if they are unclear on the concept. More prosaically, the standard AC line tester with three lamps will not work normally.

Balanced power is created through the use of line transformers. Whatever incoming service you have, the end result is typically 120V at some amperage requirement (though it can be another voltage). Therefore, the necessary transformer(s) should have a primary designed for the available service, perhaps 120V or 240V and a capacity (stated in Volt-Amps, which is essentially watts into a purely resistive load) sufficient for your technical power needs.

The first step is to take a power inventory of your facility to determine the total tech power draw. Most equipment will state somewhere on the rear panel or in the manual either current or watts drawn. In general, it is wise to use VAs rather than watts when determining power consumption for a device. This is because watts can be misleading if the device's power factor is not known. Using VAs based on a device's actual current draw will ensure adequate power system size even for equipment with heavily reactive load characteristics (such as big motors). Add it all up, add in your expansion needs and throw in some extra for good measure. The reality is that most equipment draws less current than rated, most of the time, but start-up surges (such as from one-inch VTRs or film dubbers) must be considered, as well as changes in efficiency due to temperature. Plus, those big digital boxes, like DVEs and switchers, are real juice hogs and might not be fully loaded when first purchased.

The tech power can be derived from a single transformer or several depending on the service. For instance, at Fast Cuts (see Figure 1) there was 120/208V/100A three-phase service available, which can provide three 100A supplies. Three transformers were chosen that could be strapped for 208V primaries and 120V center-tapped secondaries (thus creating the balanced 120V). The terminology of these transformers can be tricky, so be sure the supplier or contractor understands what you want. Purchasing transformers from such a company as Equi=Tech eliminates this problem and also provides precision-wound secondaries that are claimed to give better common-mode cancellation. However, precision transformers are significantly more expensive than common industrial models; the 8kVA unit in this system was about $1,500.

For the Fast Cuts facility, Equi=Tech supplied toroidally wound transformers, which have higher power capacity for their size than conventional laminated-core designs (and well-contained magnetic fields), but had two peculiarities that caused trouble during installation. First, if the transformer is mounted vertically, such as on a wall, support can be provided using the hole in the plastic core but there must not be a completed turn of electrically conductive material through the core. (See Figure 2.) The introduction of a closed electrical circuit through the core acts like a shorted winding and can damage the transformer.

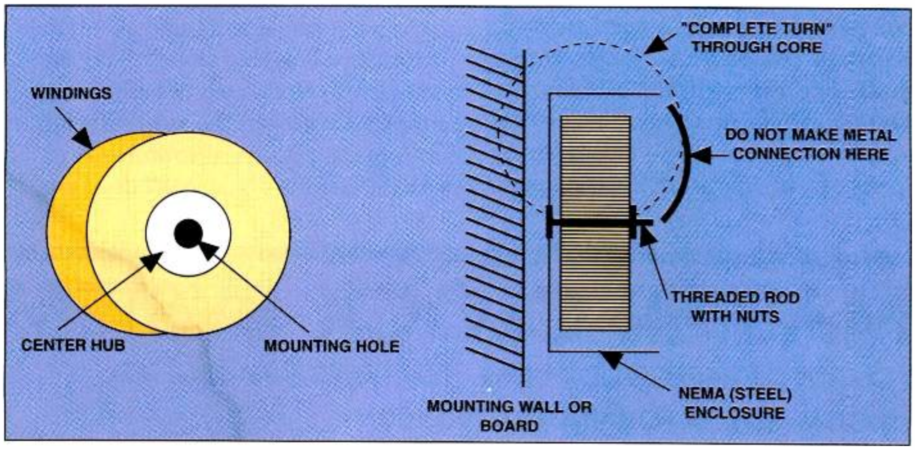

Figure 2. For proper operation, toroidal transformers must be mounted with care. Check with the manufacturer for recommendations.

Secondly, though the system in Figure 1 was installed with a 90A three-phase main breaker ahead of the transformers, the breaker would not hold when powering up even one of the transformers. The transformer manufacturer quoted short-duration inrush currents as high as 5,000 amps for the 5kVA units! This was probably due to the transformer cores being undersized and reaching saturation too quickly at start up. Because it was not possible to get a circuit breaker with extremely high inrush specs, a 90A fused disconnect was substituted. This brings up a good point: do not hesitate to contact the transformer manufacturer for technical help with installation, particularly in the areas of lead identification, mounting and cooling.

The code and other issues

Balanced power is first addressed in the National Electrical Code (NEC) with the 1996 revision (thanks to work by Equi=Tech's Martin Glasband). This legitimizes the practice, at least for audio and video facilities, and provides some specific directives. For the most part, these directives are common-sense, though sometimes tedious. Because the NEC's sole purpose is to ensure human safety, it is wise to stick with the letter unless you can foresee the consequences of straying. In the end, a given electrical inspector may make unreasonable trouble about a balanced installation, even with support of the code, or may let things slide if he or she understands what is being done.

One problematic aspect of the balanced power code requirements is that each branch circuit must be supplied with a Ground Fault Circuit Interrupter (GFCI or GFI). The reason is to protect against shock in the event someone touches ground while also touching a device whose case is connected to the "neutral" line cord lead. The code addressed this problem in conventional power systems with the polarized two-prong plug, but with balanced power both sides are at 60V so the polarized plug does nothing. In practice, however, this scenario is unlikely because most professional equipment has a three-wire cord or an isolated chassis.

More important, the typical GFI is designed to trip at only 5mA of leakage current. Unfortunately, in any collection of average professional equipment, a few devices will exhibit this much leakage just from shunt currents in their power supply filters or leaky capacitors. There is nothing functionally wrong with the equipment, but the GFI will trip the instant power is applied. One solution is to install GFI circuit breakers, with adjustable trip current, in the tech power panels, but this is expensive. Another approach is to examine the offending equipment to determine and fix whatever is causing the leakage current.

The code also specifies double-pole breakers for the branch circuits, which is important. Though it increases the cost marginally, without double-pole breakers a branch circuit is never truly off. From an overload or short-circuit standpoint the protection is the same as with conventional power; excessive current draw on either leg will trip the breaker. In addition, the panel box must have power buses isolated from the box itself, such as for 220V distribution. Isolating the ground bus is not really necessary (see final section). Other code requirements, such as labeling circuits and receptacles, are actually a good idea anyway in order to maintain the integrity of the technical power system. That is, all equipment with system signal connections must be powered from tech power, and all non-production equipment (such as copiers) must be kept off tech power.

Clean tech power

A few issues about the power and grounding system remain. As far as line conditioning, regulation and backup power go, these must be addressed on an individual basis depending on budget. In the facility described here, no attempt was made to provide voltage regulation. Most decent equipment already has internal regulation that is sufficient to handle minor fluctuations in line level. I have also known large tap-switching regulators to go haywire and wreak havoc with the power. Similarly, no backup system was provided, though individual UPS units may be added for specific vulnerable devices, such as graphics computers and editors.

In terms of spurious noise and spike control, since balanced power is created using transformers there is the inherent benefit of an isolation transformer between your tech power and the power company. The transformer acts as a steep low-pass filter that reduces high-frequency noise. Surge protection for Fast Cuts was handled by installing some large metal oxide varistors (MOVs) at the breaker panels. These should be rated for the nominal rms voltage (but also sized to handle potential long-duration power-line fluctuations).

Another potential source of equipment damage is when power browns or blacks out then flickers on and off before returning. To alleviate this, we installed some relays that monitor the incoming power phases. If any of the three phases drops out, a giant master relay (a 90A industrial "contactor") disconnects all three phases. This relay must be reset manually, which allows facility personnel to determine when the incoming power has stabilized.

Finally, what about grounding? As previously mentioned, I have lost faith in star grounds, ground rods, telescoping shields and the like. They are cumbersome to implement and solve little. In the facility described here a "brute force" approach was taken: all cable shields connected at both ends, power system grounds connected to racks via third pins and power strip cases, all racks bonded together with bolts and star washers, as well as heavy ground straps to outlying racks, extra-large ground conductors installed between transformer center-taps, breaker panels and distant subpanels.

The idea was to create the lowest-impedance ground possible. This makes it easier for ground-borne noise to return to its source and reduces the possibility of voltage differential problems by bringing all parts of the system closer to the same electrical potential. In practice, the use of balanced power and good layout and shielding practices are meant to prevent the admission of noise into the system, but a solid low-impedance ground is the foundation. The transformer center taps and electrical grounds are bonded to the building (power company ground) via a large conductor coming in with the three-phase from the electrical room (the three-phase neutral is not used).

The presumption here is that shields can always be lifted or ferrite beads installed if noise is found, but so far this has not been necessary. The facility has been in operation since January of 1996, with technical areas covering about 2,500 square feet. There has been no sign of video hum or audible noise (apart from the occasional bad equipment). Although there are plenty of balanced audio and video devices, there are also numerous unbalanced devices, some with two-wire line cords. It just doesn't matter. Admittedly, implementing this type of power and ground system in a large facility would be more difficult, but I believe it is worth considering these "unconventional" approaches. One day they may be considered conventional. ■

> Installing a balanced technical power system is only moderately different from conventional power.

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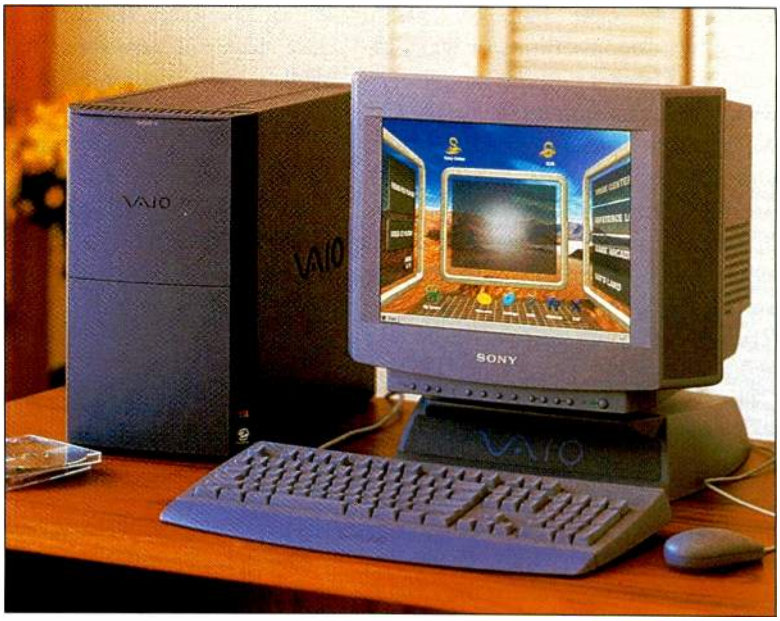
A PC by Sony and other computer products go home

Sony's entry into the home PC arena joins loaded laptops, stunning still cameras and portable storage successors.



By Marjorie Costello

This is the first of a two-part look at important introductions in the home PC area. With the PC becoming a mainstay of American life, companies typically associated with making televisions are lining up to get into the business. At the same time, computer companies are tapping their technology to create the next generation of televisions and handheld devices. In the home PC explosion, CE and computer powers are collaborating on new products, with start-ups and spin-offs ready with solutions to portable storage problems. And, as more computers go home and millions go online, the movement is creating new uses for products originally designed for another purpose.

Some of the new home PCs will be used by video professionals for traditional computer chores, such as word-processing and going on-line. The legions of laptops entering the market will provide portability and power — without the price premium — for presentations and on-location signal and machine monitoring. With their expanded multimedia capabilities at lower price points, PCs will expand the use of CD-ROMs — and eventually DVD-ROMs — for training and company communications.

Equipped with faster processors, expanded memory and larger hard drives, home PCs will also be called into action by production operations and prosumers as desktop video tools. Enhanced and simplified communications available on consumer-level products will also make it possible for more companies to connect their employees to internal "intranets," as well as to the vast offerings of the World Wide Web. Some of these new products, as they reach the mass market, will create a demand for services among video professionals. Others signal a new direction for companies who have been among the mainstays of video — professional and consumer.

PC by Sony

The debut of Sony's line of home PCs should be of special interest since the company is a major player in the professional video world. The launch also signals the beginning of a new direction for the 50-year-old company, likely to affect other Sony divisions. Sony's vision for the future includes a shift from its identity as an audio/video company to an organization described by Sony

Electronics president, Carl Yankowski, as an AVCC (Audio Video Communications and Computer) company. Now that home PCs have, in Yankowski's words, "reached a critical mass," the company that gave the world the Trinitron, the Walkman and the Betacam, thought the time was right for the PC by Sony.

Sony, like many companies in the computer field, is not going it alone, with its line developed and built in cooperation with microprocessor power Intel. The two-model Sony line, the PCV-90 with 200MHz (Intel's current fastest) Pentium microprocessor and 166MHz Pentium-based PCV-70, range in price from $2,000 to $3,000, with emphasis on offering a high-end multimedia PC for consumers. The PCV-90 offers 32MB of RAM and a 2.5GB hard disk, with the 70 incorporating 16MB of RAM and a 2.1GB hard drive.

The mini-towers housing the CPU and drives of PC by Sony are dark gray and include a purple sliding door covering the CD-ROM and floppy drives. The towers are designed to operate with a 15-inch monitor with two built-in mid-range stereo speakers mounted on either side, a built-in mic and a subwoofer, incorporated into a tilt/swivel stand. The medium gray monitor, slated to sell for $599, matches the keyboard and mouse, and the company promises a 17-inch monitor at a later date.

> In the home PC explosion, CE and computer powers are collaborating on new products, with start-ups and spin-offs ready with solutions to portable storage problems.

The models' common features include 3-D accelerated graphics, an eight-speed CD-ROM, floppy drive, 28.8 modem, universal serial bus, full-duplex speaker phone, an extensive software bundle and what the company is calling "Sony-Tuned MPEG decoding." To expand the number of operations that can provide CD-ROM mastering services for the MPEG-1 titles, Sony is now marketing the RTE-3000 MPEG-1 encoding system. Geared toward entrepreneurial CD-ROM publishers, small A/V departments, educational institutions and small business, the real-time encoder ranges in price from $29,995 to $79,995.

The home PCs will be sold primarily by Sony's major consumer audio/video accounts, which started late this summer. In addition, the company said it will likely distribute the line through a few computer chains. To support the line, Sony is promising top-notch service and technical help, through SOS (Sony On-line Support), with the company setting up a new call center in Florida. Because the PCs are equipped with a DSVD modem — that allows consumers to be on-line on the same phone line they use for voice — customers will be able to speak with tech support while their systems are being diagnosed.

PC by Sony is the first to carry the Video Audio Integrated Operation (VAIO) "concept" logo, which the company says will appear on future audio, video, computer and communications products to signify their convergence capabilities.

The VAIO name is also carried over as the name for the 3-D graphical user interface (GUI) developed for the Sony home PCs.

Called VAIO Space, the GUI rides on top of Windows 95. While in the space, computer users can see film clips from the company's motion picture company. There's an A/V media wall, an application space, a utility base and net space, with single click connection to on-line services, the Internet, SOS and Sony's web site.

Sony changes strategy gears for PCs

Sony, concerned with the often razor-thin margins in the PC industry, decided to diverge from the strategy it has followed through the years in audio and video, for the professional and consumer markets. Many would agree that Sony's success has been based on marketing a product offering more technology and features than the next brand and getting the customer to pay more for it, with Sony's prestige image also playing a role.

Compared with the other PCs on display at this past June's PC Expo in New York (a computer trade show now second to the fall COMDEX in attendance and product debuts), Sony's models offered many of the same features available from the competition at Compaq, IBM and Packard Bell. However, with the name "Sony" as a powerful draw — underscored by a recent Harris Poll survey naming Sony as America's leading brand — it's expected that the new home PC line will attract many customers.

Because of Sony's pricing concerns, the company decided not to include features and capabilities many would have expected from a company with a franchise in video. Among the features not included — or offered as an option — are video phone capability, a TV tuner card, desktop video, Intercast, high-quality video out and integrated AV equipment control.

Compaq, the current market leader in home PCs, will be adding Intel's new Video Phone technology to its home PC line this fall, with IBM and others expected to follow. These consumer-priced PCs are likely to compete with more expensive videoconferencing solutions specifically targeted toward the professional video market. Sony would not say if and when Intel's Video Phone technology would be added. However, with Intel collaborating with Sony on the home PC line, it's more than likely the feature will be added in future PCs by Sony.

The same is also probably true of Intercast support, since Intel is one of the major companies supporting this system for delivering data to PCs via broadcast and cable signals' vertical blanking interval. Compaq was the first PC company to add Intercast boards and software to its models, which debuted during the Olympics in select models sold in the Atlanta market.

For video professionals — and especially prosumers, the most disappointing omission in Sony's first home PCs is desktop video. Although the PCs can be fitted with add-on boards and software for capturing, compressing and manipulating full-motion video, it was a bit surprising Sony did not offer these products as options. Companies, such as Packard Bell (without Sony's franchise in video production), have offered video capture boards and editing software in recent models.

First FireWire board and a look to future features

On the other hand, Sony did introduce its first FireWire board, the DVBK-1000. When connected to a Sony Digital Handycam and a Windows 95 or 3.1 computer, still images can be captured digitally as computer data without the signal loss associated with analog conversion. The card and software carries a $799 suggested list price. Although the board would qualify to some as "desktop video," the fact that it doesn't capture full-motion video or work with analog camcorders would limit its card-carrying status in the desktop video world.

High-quality video output, although more critical in notebook models used in portable presentations, is another feature we can hope Sony will include in future desktop models. With Sony also planning to introduce notebooks under its own name — with the company making some Apple PowerBooks models since the line debuted — we anticipate that high-quality video output will be included in the portable PCs by Sony, expected in the next year or two.

Sony has also said that future desktop models may include a DV tape drive. Because pro DVCAM recordings are designed to be playable on Sony DV consumer decks, hopefully, the compatibility will extend to Sony's home PC DV drives when they arrive.

A peripheral Sony has gone on record as saying it will add a 100 CD-ROM changer, a useful playback option for training and educational applications. Also promised is a DVD-ROM drive, once that format moves into the market. Another feature Sony hinted we would see is a board and software for capturing, decoding and displaying DSS signals, although it's rumored Compaq will be the first to offer the capability.

Other extras that could show up in a PC by Sony include a TV tuner card for watching broadcast and cable channels. Your productivity will not suffer too much because Sony has no plans to offer a board incorporating the highly successful PlayStation video game system, although the Sony PC will offer easy connection to the Internet and online services.

A new category, the PC/TV (or TV/PC) is moving into full swing, led by Gateway's Destination. Compaq and Thomson (RCA) are collaborating on a series of convergence products, with a PC/TV promised as the first offering. Toshiba has also hinted it will combine its experience from computers and television in the PC/TV category. We should know more about Sony's plans in this category in the near future.

Look for more information on laptops, still cameras, and portable storage in the next column. ■

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By John Battison, P.E.

Winterizing your tower

This is the time of year when wise engineers start looking for trouble, not hoping to find it, but hoping to avoid it. It is time to look at those essential, but often forgotten and neglected, towers that are a major part of the broadcaster's last link with the viewers.

If the tower was built in pre-WW2 days, it behooves you to take a good look at mechanical items. However, from my experience, these towers were generally built by adequately financed licensees who did not skimp on tower construction. Regardless, after 50 or so years, materials do begin to rust, no matter how good the original. Other items also begin to show signs of age.

At first, the TV explosion did not result in many new TV-only towers. Existing AM owners realized they already had an antenna-supporting structure in the form of their AM towers. Sometimes, it was necessary to erect a new, taller combination AM/TV tower, but in many cases, the existing tower was used.

Some of these were built by penny-pinchers who had to skimp on materials to get on the air. Since then, in many cases, maintenance has been ignored. Judging from those towers I have visited, many might well have more paint than steel in their present physical construction!

AM/TV combos

The combination AM/TV tower brings us to two important considerations. One is tower strength involving the new TV antenna, plus possible iceloads. The other is bypassing the base insulator. Basically, there are two ways of doing this. One is by using a quarter-wave matching stub usually running up the tower, although sometimes horizontally on the ground; or an iso-coupler can be used. This consists basically of a coil of coaxial line at the base of the tower that carries the TV signal and also serves as an inductance across the base insulator tuned to present a high impedance at the AM frequency.

Some of the older, original TV stations that still use a TV radiator mounted on AM towers encounter problems. It often became necessary to build tall AM/TV towers as high as 1,100 feet AGL to provide enough TV height. To obtain efficient operation at the AM frequency such towers were usually treated as Franklin radiators and were of split construction with special driving systems for each of the AM radiating sections. The last example that I know of was the old NBC station in Cleveland, OH, where Channel 4 was supported on a 1,100-foot Franklin radiator.

I have found that many of the combination AM/TV towers using quarter-wave matching stubs, Franklin design principles and other isolating methods have changed impedance over the years. When performing tower maintenance on such towers, it is essential to measure the AM match with a bridge and to reset it if necessary.

Paint should have been scraped off the tower legs when originally installed. Over the years, moisture can work its way in and produce rust and other forms of solid-state conductors that result in strange spurious RF radiations. It can also change the matching impedance.

If you are lucky, you will be able to find a tower crew who can also perform a mechanical inspection and fine-tune the isolating system adjustment. In the old days, shouting up the tower was the usual means of communication to the adjuster. Consequently, adjustments were often not that precise. Today, we as engineers in the completely RF device-driven communications field should use some form of radio communication. But remember — don't use ham equipment to do it — the temptation is great, but the FCC's penalty can be heavy.

If funds permit, hire a tower specialist to make the inspection. He or she will report on the rust and steel safety situation, as well as paint condition. Have all the section joints inspected for rust and corrosion. Guy wire attachment points must be checked, and guys require a careful inspection. Guy greasing seems to be ignored at many stations, but it is an important factor in maintaining tower life and can extend guy life.

Don't overshoot

Be sure to check guy tension and tower vertical angle. Over the years, many a tower has acquired a slight tilt. If you have a TV antenna with more than a few bays on the tower beware. Unnoticed beam tilt can affect coverage. If you've received reports of poor TV coverage in some direction, check the tower's vertical alignment. With a high gain UHF antenna, a mechanical tower beam tilt of only 1° can cause your signal to pass over the desired area in one direction and fall short in another. I recall one TV station whose new TV antenna was carelessly installed with a 1° tilt, due to lack of shimming, and an important coverage area was lost until the installation was corrected, but only after a lot of complaints.

Don't neglect the feedline while checking for mechanical problems. Put a Time-Domain-Reflectometer (TDR) on the line and check for loose/burned bullets and line malformation. Properly used, the TDR can even give early warning of antenna problems.

For towers in general, check the guy anchors. Have your inspector dig down to check for guy footing deterioration. Also look for rusted eyelets and turnbuckles that are not locked or are rusted out. Lighting installations are often overlooked. Be sure that all conduits are adequately bonded to the tower and that lighting fixtures are sound and not cracked or missing. If you have a dual beacon be sure that both lamps are good and working. It goes without saying that the photocell system should be checked, not only for turn-on in darkness, but also under FCC specified light conditions. Any light-sensing devices for remote control should be confirmed to be operating also.

If you have strobe lights, check that the daytime/interim/night lighting power change is working properly. We often see strobe systems with faulty power change switch gear that continues to run the daytime power at night — much to the annoyance of people living in the vicinity of the tower. The opposite is more dangerous — reduced night power in daytime is a big NO NO!

Sometimes the flasher rate for the system changes and gives unusual combinations of lights. Some systems carry the high strobe voltage to each light via heavily insulated cables. Check these to be sure that there are no worn or weak insulation spots where a short can occur. Most of the newer systems generate the high voltage at the individual light fixtures. These generally use a power pulse from the ground controller to initiate the discharge.

Gaskets on the individual strobe power generation boxes are a common source of trouble. Make sure that gaskets are replaced as necessary and that they are not caught in the lid or cover as these are replaced, with the consequent risk of water entry.

Be sure that remote-control sensors are working properly and telling the correct story to the control point(s). If you are one of the unfortunate licensees with red and strobe lighting, it is particularly important to check that both systems are working properly and that the remote sensors are actually verifying the condition of the tower lights.

Finally, be sure that your board operators or remote-control personnel are absolutely sure of the correct procedure to follow in the event of light failure. Be sure that the correct FAA number(s) are posted together with the proper instructions. The FCC and FAA take a dim view of incorrect tower light failure reports.

Tower base footings must be checked. Sometimes they develop cracks that can fill with water and allow ice to form and crack the concrete. Sometimes concrete begins to crumble for no apparent reason. Get a good concrete engineer to examine the footing and follow his or her advice. Dig down a little and see what it's like under the ground; but be sure not to damage the connections to the grounding system.

This is also a good time to examine the grounding system if you have a TV-only tower. A surprising number of TV towers were built with inadequate grounding facilities. If your station has been hit more often than your competitors, or more than is reasonable, take a look at what the long-past installer provided to take care of lightning surges.

It is surprising how many TV-only towers have only one or two eight-foot grounding rods loosely tied to the tower base. Although there is no need to be as elaborate as an AM station's system, something better than one rod is essential. A lot depends on the type of soil around the tower. In sandy or rocky soil, it is advisable to install at least eight grounding rods connected to the tower with short four-inch or wider copper straps; not a piece of six- or eight-gauge copper wire. A long run of small-gauge wire offers enough reactance to a lightning strike to divert the strike to the lower impedance transmitter and associated equipment. A copper strap has a far lower impedance. Chemical grounding systems are becoming popular in rocky/dry soil. Generally, these require only a little maintenance during the year, but they are usually well worth the trouble in preventing the damage and cost caused by uncontrolled lightning strikes.

Guy greasing seems to be ignored in many stations, but it is an important factor in maintaining tower life and can extend guy life.

If you have a combination AM/TV tower, look at your tower base insulator. It goes without saying that it should not be cracked. Sometimes it is hard to observe cracks, and once again an expert's services might be worth the cost. Remember, a small crack can contain water that will freeze and ice's power of expansion in moving large objects is amazing!

Pay special attention to bonding on the tower between tower lighting, other antenna transmission lines and any other devices that are hung on the tower. Poor bonding to these items can cause all kinds of operating problems in a combination system. Vibration sometimes loosens bolts and holes elongate. Your inspector should check these items.

Tower requirements revision

At this time while thinking about your tower's condition, consider the current tower loading. Over the years, the ANSI standards have been revised upward as far as minimum wind- and iceloading are concerned.

Consequently, standards for towers have been revised upward in many states, especially for ice- and wind-loading factors.

Most stations carry tower insurance, but if your tower falls and the insurance company can prove it was overloaded, you might have a problem with your claim. Not only could your loss of airtime insurance fail to pay off, but if anyone is injured or property is damaged, the insurance might not cover these events, and they could be even more expensive than loss of air time!

In 1991, the ANSI/EIA/TIA standard 222 was revised and revision E became effective. This gives particular emphasis to the effects of multiple antennas and transmission lines on broadcast towers. The standard is too long to cover fully here, but one of the major items of interest to broadcast engineers is the method of estimating windload requirements.

> If you've received reports of poor TV coverage in some direction check the tower's vertical alignment.

Prior to revision E, maps of the states carried isobars showing basic wind speeds at an elevation of 33 feet above ground in 10mph increments. These were close together and it was difficult to determine the value in many counties. To overcome this, revision E provides a tabulation of minimum basic wind speeds for each county in each state. Special wind zones, or areas, are highlighted. Iceloads still have to be calculated and general tower windloading determined.

Methods of triangulation to determine tower twist and out-of-plumb conditions are given in the new revision. It is important that the person performing the tower inspection be familiar with the latest ANSI revisions.

As time passes, communication towers are proliferating rapidly as cellular phone and microwave towers spring up. States, counties and local townships are jumping into the act with rules and zoning that increase the difficulty of obtaining new tower permits.

If a tower falls and causes damage to property or personnel, it may become impossible to obtain permission to rebuild it. Station engineers must consider these things, and if necessary, beat on management's door to get funding for a thorough tower inspection before the winter winds make it too late and your tower is down for keeps! ■

John Battison owns John H. Battison and Associates, a consulting engineering company in Loudonville, OH.

Continued from page 6

handsomely. In terms of economics, the idea of a simple, low-cost, effective compression system on a chip is extremely attractive. If I was still running the marketing of a broadcast equipment vendor, my booth at NAB next year would be full of interesting applications using the device. Judging by some of the broadcast/near-broadcast people I saw talking with Analog Device's staff at Comdex, that may well be the case.

"Quality" in the new chip is going to depend on the use, but having been a professional looker at video signals for the better part of 30 years, the signals that I have seen are impressive.

MPEG-4 is going to be complex, and I hope that wavelets are now "grown up" enough to get more than just the hearing they got at MPEG-2. My concerns about MPEG-4 are that the range of people, uses, users and sources is going to be so vast that the committee will be tied up for a long time and that what will eventually emerge will be another "toolbox" standard. In recent conversations with some of those who are readying their submissions for the first work, there seems to be a uncertainty about what they want from the standard.

Thank you for your comments and interest.

Regards,
Paul McGoldrick

preview

Coming in October:

COVER STORY

From single channel to multichannel, step by step

The FCC is close to authorizing multiple channels of video broadcast and stations have to build now. Read about the issues surrounding the design and construction of control rooms, routing facilities and production suites that must handle multiple channels of video.

1996 salary survey

In addition to the graphs and numbers, BE *readers can look forward to some interesting opportunities for their careers.*

new products

By Deanna Rood

Protocol translator
Leitch

• SPT-1000-SXY: a translator that allows Leitch routers to be controlled by other manufacturer's control systems and conversely, allows Leitch's control systems to control other manufacturer's routing switchers; the translator fits in the palm of your hand, can be mounted to the side of a rack or left in-line along a length of cable; the translator has sufficient memory to store several protocols.

Leitch, 920 Corporate Lane, Chesapeake, VA 23320; 800-231-9673; fax 804-548-4088
Circle (250) on Action Card

Telescoping camera tower with robotics
TreeTop Systems

• TreeTop camera elevating tower & robotics system: the system consists of three modular parts—a telescoping tower, a robotic pan/tilt head and a command control center; the tower reaches a maximum elevation of 21 feet in 30 seconds (40-foot models are available on special order); it is designed to withstand rugged use under a variety of environmental and topographical conditions; the tower retracts into a compact 150-pound, six-foot one-inch long package and is easily transportable in its own high-impact travel case.

TreeTop Systems, 191 Post Road West, Westport, CT 06880; 203-221-2700; fax 203-222-9163
Circle (251) on Action Card

Re-recordable digital optical disc
Panasonic

• LQ-D5500: a record/erase digital optical video disc recorder/player that provides broadcast-quality, high-density digital recordings; the LQ-D5500 records up to 41.5 minutes of DVCPRO video and two high-quality 48kHz/16-bit digital audio (PCM) channels; with an average access time of 0.5 seconds across the disc, the LQ-D5500 offers a dramatic advantage in editing and production speed.

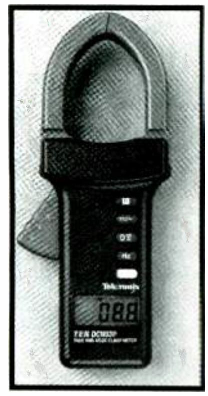
Panasonic, One Panasonic Way, 2A-2, Secaucus, NJ 07094; 201-392-4319; fax 201-392-6001
Circle (252) on Action Card

High sampling rate DAT recorder
Pioneer/HHB Communications

• D-9601: a high sampling rate DAT recorder that is compatible with Sonic Solutions' Sonic System digital audio workstation; the D-9601 and the Sonic System present a sonically superior option over analog and other digital systems while paving the way to a 96kHz future; the D-9601 records and plays at 88.2 or 96kHz yielding a frequency response of 44,100 or 48,000Hz.

HHB, 43 Deerfield Rd., Portland, ME 04101-1805; 207-773-2424; fax 207-773-2422; 75671.3316@compuserve.com
Circle (253) on Action Card

Digital clamp meter
Tektronix



• DCM330, DCM320 & DCM300: advanced digital clamp meters that are convenient to use in any situation; the DC current capability and peak hold function help ensure that you will never miss information; autoranging and 4,000-count resolution make the DCM300 and DCM320 quick and easy to use.

Tektronix, 14180 SW Karl Braun Dr. MS 50-216, Beaverton, OR 97077; 800-426-2200; 503-627-4697; fax 503-627-5593; www.tek.com/measurement
Circle (254) on Action Card

Video display system
Electrosonic Systems Inc.

• 2xView: a self-contained, multi-input video display that efficiently houses Electrosonic's processor, the IMAGESTAR; the upper projector is nestled above the lower projector to save space; with a footprint of 30 inches, this system stands 43-inches wide and 96-inches high and houses screens of 53-inch diagonal.

Electrosonic Systems, 800-328-6202; 612-938-9311; videowall@esonic.usa.com
Circle (255) on Action Card

Computer-based A/B/C/D roll edit controller
Videonics

• VideoToolKit 3.0: a multifunction video editing software program that allows PC-Windows 95 and NT 4.0 users to harness the power of their personal computers to edit video productions; Video ToolKit 3.0 turns a computer into an edit controller allowing you to build on-screen edit decision lists and rearrange scenes with the click of a mouse or with a standard joystick.

Videonics, 1370 Dell Ave., Campbell, CA 95008-6604; 800-338-3348; 408-866-8300; fax 408-866-4859; www.videonics.com/; info@videonics.com
Circle (263) on Action Card

Progressive scan camera
Sony Electronics

• DXC-9000: a three-CCD color video camera that dramatically reduces blur and captures clear, high-resolution images of moving objects by incorporating progressive scan technology and both NTSC and VGA output; because the images are stored as square pixels, the DXC-9000 can help avoid aliasing and provide clear image capture and manipulation for computer graphics applications.

Sony, 1 Sony Dr., Park Ridge, NJ 07656, 800-472-SONY
Circle (256) on Action Card

Shortcut personal audio editor
360 Systems

• Shortcut: a self-contained stereo editor that combines a familiar interface with digital editing power; unlike tape, the Shortcut is always ready to record — the record button is always active and it immediately captures incoming audio, no matter what the user was doing before; because Shortcut records directly to a large internal hard disk, all audio material is on-line for immediate access.

360 Systems, 5321 Sterling Center Dr., Westlake Village, CA 91361; 818-991-0360; fax 818-991-1360
Circle (258) on Action Card

Real-time video system
Truevision

• TARGA 2000 RTX: an upgrade to the TARGA 2000 Pro that brings real-time processing and the highest I/O throughput to the desktop; the system is designed to meet the needs for an open-system solution for nonlinear editing and desktop multimedia production; the TARGA 2000 RTX delivers real-time DVE, broadcast-quality video and professional I/O connections with support for industry-standard video file formats under the Apple Mac OS and Microsoft Windows NT operating systems.

Truevision, 2500 Walsh Ave., Santa Clara, CA 95051; 800-522-8783; www.truevision.com
Circle (257) on Action Card

Digital routing switchers
Sierra Video Systems

• Model 64 x 64: line of large serial digital routing switchers including the 6464D, a 4RU modular design available in 16 input or 16 output increments from 32 x 32 to 64 x 64; the inputs are auto-equalized and outputs are reclocked for 143, 177, 270 and 360Mb/s data rates; companion to the 6464D is the 6464E serial digital audio routing switcher.

Sierra Video Systems, PO Box 2462, Grass Valley, CA 95945; 916-478-1000; 916-478-1105; info@sierravideo.com
Circle (260) on Action Card

ISDN audio codec
Comrex

• Nexus: a complete ISDN codec, terminal adapter and NT1 combined into one package; the Nexus can send 15kHz bidirectional audio on BRI ISDN and is compatible with all standard G.722 codecs; it also provides ancillary data capability for linking your laptop with your station.

Comrex, 65 Nonset Path, Acton, MA 01720; 508-263-1800; fax 508-635-0401
Circle (261) on Action Card

Agile demodulators
Videotek

• DM-145: a 154-channel, agile cable-ready demodulator that is ideal for monitoring broadcast and cable channels; it provides simultaneous stereo audio and second audio program (SAP) outputs.
• DM-154: a 154-channel, high performance cable-ready agile demodulator ideal for broadcast video testing due to its zero carrier chopper mode, its ICBM quadrature output, its IF loop capability and its composite audio out for stereo testing or re-modulation.
• DM-192: modulator featuring 192 channels that lends itself to broadcast and cable TV video services and testing; it features zero carrier chopper mode, ICPM quadrature output, IF loop capability and composite audio out for stereo testing or re-modulation.

Videotek, 243 Shoemaker Rd., Pottstown, PA 19464; 610-327-2292; fax 610-327-9295
Circle (259) on Action Card

MPEG-2 authoring workstation
Digital Vision

• BitPack: an MPEG-2 authoring workstation that is primarily a complete turnkey solution for the production of MPEG-2 video and associated audio files; the system is targeted to applications demanding the highest possible picture quality in the mastering process and uses the full MPEG-2 algorithm toolbox; BitPacks' real-time MPEG-2 encoding capabilities provide a powerful feature set to meet the exacting needs of demanding DVD encoding, servers, multimedia, archival storage or real-time playout.

Digital Vision, 11835 West Olympic Blvd., Los Angeles, CA 90064; 310-914-5200; fax 310-914-0011; peo@digitalvision.se
Circle (265) on Action Card

Hand-held zoom lenses
Fujinon

• A18X9 & S18X6.7: a family of hand-held zoom lenses that bridge the gap between low-cost professional lenses and high-performance lenses designed for broadcast applications; the 18X lenses offer the widest angle and highest magnification of any of the lenses in their class; they are designed for rugged service and are extremely durable; the use of aspheric technology also allows them to be extremely lightweight.

Fujinon, 10 High Point Dr., Wayne, NJ, 07470; 201-633-5600; fax 201-533-5216
Circle (262) on Action Card

Compositing device
Ultimatte

• Ultimatte-8: an all-digital, full-featured compositing device that produces realistic composite images even when the foreground contains things such as smoke, shadows, soft edges, transparent objects, fine details, reflections and shades of blue; the device features user-selectable input and output that can be individually configured to serial 4:2:2:4 or 4:4:4:4.

Ultimatte, 20554 Plummer St., Chatsworth, CA 91311; 818-993-8007; fax 818-993-3762
Circle (277) on Action Card

Two-way radio interface
Clear-Com

• TW-20: a two-way radio interface that allows communications from walkie-talkies to a wired Clear-Com party-line intercom system; the TW-20 is ideal for touring shows where licensed fixed frequencies might not have clear channels at every venue.

Clear-Com, 945 Camelia St., Berkeley, CA 94710-1484; 510-527-6666; fax 510-527-6699
Circle (264) on Action Card

The GALLERY

Circle (65) on Action Card

Circle (64) on Action Card

Circle (62) on Action Card

Circle (63) on Action Card

Circle (66) on Action Card

Serial digital synchronizer
Digital Processing Systems

• **DPS-465:** a serial digital video synchronizer provides a bridge between analog video signals, such as satellite and microwave feeds and your digital production facility; the DPS-465 is also a transponder and a digital test signal generator; in TSG mode, any one of 32 test patterns appear at all four outputs.

Digital Processing Systems, 11 Spiral Dr., Florence, KY 41042; 606-371-5533; fax 606-371-3729; info@dps-inc.com; www.dps-inc.com

Circle (266) on Action Card

High sampling rate DAT recorder
Pioneer/HHB Communications

• **D-9601:** a high sampling rate DAT recorder that is compatible with Sonic Solutions' Sonic System digital audio workstation; the D-9601 and the Sonic System present a sonically superior option over analog and other digital systems while paving the way to a 96kHz future; the D-9601 records and plays at 88.2 or 96kHz yielding a frequency response of 44,100 or 48,000Hz — this expanded bandwidth ensures that the low level artifacts created by anti-aliasing filters occur beyond the range in which human hearing is most effective.

HHB, 43 Deerfield Rd., Portland, ME 04101-1805; 207-773-2424; fax 207-773-2422; 75671.3316@compuserve.com

Circle (274) on Action Card

Rack-mounted version of LYNXX
California Microwave Transmission Systems

• **LYNXX:** a transportable satellite communications systems available in a rack-mounted version; the LYNXX system allows you to have the benefits of mobile or stationary satellite telecommunications without the high fixed costs of owning space segments; you can access your corporate information network from anywhere, anytime and pay only a low air-time rate for the minutes you use.

California Microwave Satellite Transmission Systems, 125 Kennedy Dr., Hauppauge, NY 11788; 516-272-5600; fax 516-272-5500

Circle (273) on Action Card

Axial editing system enhancements
Accom

• **Axial 2010 & 2050 with version 4.0 software:** editing systems with new software include new features such as roll-through auto assembly; speed ramps, speed curves and user-defined speed transitions; upload and download of device data to the Axial EDL and enhanced pre-read.

Accom, 1490 O'Brien Dr., Menlo Park, CA 94025; 415-328-3818; fax 415-327-2511

Circle (270) on Action Card

Digital recording console
Yamaha

• **02R:** a digital recording console that offers features previously only available in high-end digital console systems including unprecedented real-time automation with snapshot memory and instant reset of all console parameters including control of its internal compressors and effects; the efficient operating style offers the perfect solution for the project studio recording market, audio post facilities and the modular digital multitrack owner — whether hard disk or tape.

Yamaha, PO Box 6600, Buena Park, CA 90622-6600; 714-522-9011; info@Yamaha.com

Circle (271) on Action Card

Amplifier
MCL

• **MX3000 TWT:** a medium-power amplifier that is part of the MAXXIM series; the MX3000 is a compact, single-drawer amplifier occupying three standard rack units (5.25 inches) of height and is ideally suited for transportable, satellite uplink communications.

MCL; 708-759-9500; 708-759-5018; compuserve 74166,2571

Circle (267) on Action Card

Precision video cable
Belden Wire and Cable

• **1865A video cable:** subminiature precision video coax cable that handles analog and component and composite serial digital video systems, yet has a 30% smaller O.D. and weighs 40% less than standard RG-59-type video coax cables; it is ideal for mobile truck applications and production studio environments.

Belden Wire & Cable, PO Box 1980, Richmond, IN 47375; 800-BELDEN-4; 847-577-3618

Circle (272) on Action Card

industry briefs

BUSINESS

Digital Vision has opened a national office in the United States. The new office is located at 11835 W. Olympic Blvd., Suite 1275, Los Angeles, CA 90064; phone: 310-914-5200; fax: 310-914-0011. In addition, its U.S. distributor, Preferred Video Products of Burbank, CA, will continue to have exclusivity for the digital product line in California.

Mackie Designs, Woodinville, WA, supplied 20 of its CR1604-VLZ compact sound mixers for the Summer Olympics in Atlanta.

Quantegy, Inc., Peachtree City, GA, announced the acquisition of assets and inventory of 3M Professional Audio and Video Tape, St. Paul, MN. Quantegy will now assume responsibility for supplying 3M customers with 3M brand tape for as long as inventories last.

Discreet Logic, Montreal, Quebec, announced that Warner Digital Studios has installed two INFERNO and six FLINT visual effects systems from the company.

Florical Automation Systems, Gainesville, FL, has installed a computer automation system for Central Television GTS/BKN.

Acrodyne Communications, Inc., Blue Bell, PA, introduced its diacrode technology into the Phillipine transmitter marketplace with the sale and installation of a 120kW UHF TV transmitter to Radio Mindano Network, Manila, Philippines.

Hitachi Denshi, Woodbury, NY, has sold three of its SK-2600 digital studio cameras to public TV station KLRN-TV in San Antonio.

Philips Broadcast Television Systems, Simi Valley, CA, has sold three LDK cameras to Denver PBS affiliate KRMA-TV and three to Denver ABC affiliate KMGH-TV.

Patapsco Designs Inc., Frederick, MD, has been awarded a contract to design and integrate a new machine automation system for NBC.

Wegener Corporation, Duluth, GA, announced that Moody Broadcasting Network, Chicago, placed an initial order for primary network conversion to Wegener's Digital FM² subcarrier technology.

JVC, Elmwood Park, NJ, announced that The Fox News Channel, New York, has chosen its Digital-S as the house videotape format for all in-house recording and editing undertaken in the channel's new all-digital studio.

PEOPLE

Mike Shephard has joined TCS Management Group Inc., Nashville, TN, as managing director of the company's UK/European office.

Tom Hansen has assumed the newly created position of national dealer sales manager for broadcast products for Telex Communications, Minneapolis.

Jay Kuca has been appointed director of marketing for Sierra Video Systems, Grass Valley, CA.

Cary Capece has been named director of sales and marketing for MountainGate, Reno, NV.

Also announced by MountainGate, Chip Ray has been appointed manager, development engineering.

Debra Buck Huttenburg has been promoted to vice president, antenna systems, for the Andrew Corporation, Orland Park, IL.

Frederick L. Godard has been appointed executive vice president of Leitch Technology Inc., Toronto.

In addition, John R. Piercy has been named vice president of marketing for the company.

Susan Kitts has been appointed executive vice president and chief operating officer for the National Captioning Institute.

Donald J. Catledge has been promoted to president and general manager of RF Industries' Neulink Telemetry Division, San Diego, CA.

Thomas J. Daly has been promoted to senior marketing director for Fuji Photo Film USA, Elmsford, NY. ■

in:sync

SPEED RAZOR MACH 3.5

Digital Video Editor for Windows NT

The ultimate digital video editing software. Speed-Razor MACH 3.5 allows you to edit full screen, 60 fields per second, CCIR 601 broadcast-quality video. Designed for the DPS PVR-2500 Perception and Truevision's TARGA 1000/2000 video capture cards, Speed-Razor MACH 3.5 is the fastest and most powerful tool for editing and compositing video clips, animations, stills, music and sound effects. Experience straight cut editing in real time and effects which fly on the fastest machines out there: Alpha,Intel, MIPs-based and PowerPC-based workstations, making this the fastest, most flexible software you've ever seen. Running under Windows NT, it offers three times the speed of Windows 3.1 on the same machine and up to ten times speed when used on Alpha-based systems.

Speed-Razor features infinite video, audio, transition and effects tracks and comes with Razor Blades—transitions and effects to enhance your production. There are preset tumbles, fades and wipes which you can easily customize and save as new presets. In addition, there are special image effects which are unquestionably the highest quality of any system—analog or digital. Speed-Razor sports anti-aliased 3D DVEs, an infinite channel chroma keyer and an excellent character generator. Use the included effects or transitions, layer them to create new ones, make your own grayscale bitmaps to use as transitions, or use 3rd party plug-in effects—the flexibility is yours.

There are two user definable resolution modes (thumbnail and final) to facilitate editing. The thumbnail mode allows you to use Speed Razor in the field on a laptop then transfer the project file back at the edit suite and automatically recapture and re-render the entire project at final resolution.

RS-422 control and batch capture module allow you to automate video capture via SMPTE time code, so digitizing video and audio is simple and painless. In fact, with the innovative "Virtual Editing" function you can actually edit your project, complete with effects and transitions—before you've digitized a single frame of video.

EDITING FEATURES:
- Real-time straight cut editing (this doesn't require a new file to be made and requires less space on the hard drive to edit)
- The only video editor with the ability to cut to the field
- Work in Thumbnail or Final Output resolution mode (you set the resolution for each)

COMPOSITING:
- Infinite number of layers of video clips, still and animations can be composited together
- Handles any resolution from Betacam (720 X 480) up to Omnimax film (4000 X 4000)
- Video clips can be combined using an alpha channel, key color transparency, still or traveling mattes

FILE FORMATS:
- Reads and writes ANI files (created by DPS' PAR), PVD files (Perception), DVM files (TARGA 1000 and 2000) and sequences of TARGA files
- Convert files between any of the following formats: ANI, PVD, DVM, AVI, BMP, TGA, FLC, FLI, WAV
- Project-based Library for organizing your work

AUDIO:
- Handles audio up to DAT (48 kHz) quality
- Infinite number of audio tracks for multi-layer audio mixing

EFFECTS:
- Blur (circular, gaussian, fast), tint, brightness adjustment, chroma key, crop, displacement, emboss, freeze frame, glass texture, greyscale, invert, loop, matte, pixelate, repeat fields, scale, transparency, strobe, turn red/green/blue
- 3D DVE (translates and/or rotates an image in three dimensions on the X, Y and Z axis)
- Sets a color channel to an assignable value)
- Titles (full blown CG using any Windows font in any color with automatic drop shadow)
- Sub-pixel rendering for incredibly smooth motion
- Effects can be applied to infinite sources

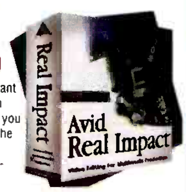
TRANSITIONS:
- Includes over 100 grayscale image transitions, crossfades, luminance fades, fade to/from black, fade to/from white, push, twirl, twist in/out tumbles, flip, turn, scale (zoom)
- Transitions can be applied between infinite inputs

In:sync Speed Razor MACH III for DPS PAR-2100 and PVR-2500 .... CALL
In:sync Speed Razor MACH III for Truevision TARGA 1000 and TARGA 2000 .... CALL

AVID

Real Impact

Windows NT-based Video Editor for TARGA 2000



Real Impact provides the same professional image quality, intuitive cut/copy/paste editing, and instant random access capabilities that have won Avid 2 Emmy awards—for thousands of dollars less than outsourcing an average video. Designed exclusively for Truevision's TARGA 2000, Real Impact lets you create professional-quality video with audio, graphics, animations, special effects and titles—with the speed, flexibility and creative freedom you need. Create sales, training and product videos right on your PC quickly and easily—without compromising quality. Produce video in 24-bit color, with CD-quality sound and perfect lip sync.

Includes free upgrade to AVID MCXpress ($2000 Value)

Easy to Use: A true 32-bit application (Windows NT 3.51), Real Impact's intuitive interface and extensive on-line help get you productive right away. It's powerful editing features let you work with video, audio, graphics, animations and titles with the simplicity of cut, copy and paste.

Video Capture: Digitize video and audio–without dropping a frame. Video is full-screen, full-motion, 60 fields-per-second and your audio in sync. It's Dial-a-Quality image feature lets you adjust image quality for differing system, storage and delivery requirements.

Create a Storyboard: Extensive media management with built-in media library and database lets you easily find the video and audio clips that you want. Instant access makes previewing edits simple and immediate. And, with timeline editing, you just click and drag to experiment with different cuts, rearrange clips and assemble your story. There are 32 levels of undo and redo.

Add Graphics, Titles and Special Effects: Create and seamlessly incorporate audio, graphics and animations into your video using popular Windows-based applications. Real Impact supports AVI video files, WAV audio files, FLC animation files as well as BMP, JPEG, PCX, TGA and TIFF graphics files.

Add Audio: Polish your audio with music and narration. Adjust pan and volume in real time. Simultaneous playback of four audio tracks makes audio editing quick and easy. View your four audio tracks in sync with the video immediately, no waiting for tracks to compile.

Digital Media Interchange: Compatible with the Open Media Framework (OMF) Interchange, a file format for the seamless integration of digital data among applications and across platforms. Through OMF, you can import video and audio files from other OMF-compatible applications like Avid's Media Composer.

Output to Tape, CD-ROM or Over a Network: Gives complete control over video distribution. There's no long rendering process, creating professional quality tape is a snap. Embed video in multimedia presentations for distribution on disk or CD-ROM by simpling clicking a mouse. Supports third-party MPEG tools to create MPEG files for network distribution.

Avid's Support Advantage: Real Impact is backed by Avid's world-class customer service. Toll-free telephone support and bulletin board service are just some of the benefits.

FEATURES:

Video
- Real-time JPEG compression/decompression and playback at 60 fps
- Supports RS-422 control protocol and SMPTE time code
- Edit two tracks of video for layered effects.

Audio
- Edit up to four tracks of 44.1 KHz, 16-bit CD-quality audio.
- Real-time pan and volume adjustments, digital audio scrub.
- Waveform for precise audio editing.

Import/Export
- AVI video files, WAV audio files, FLC animation files.
- OMF Interchange files.
- BMP, JPEG, PCX, TGA and TIFF graphics files.

Special Effects
- Filter effects with previews and adjustable parameters.
- Transition effects include wipes, dissolves, zooms, pushes and squeezes.
- Layered effects include picture-in-picture, luminance and chroma key.

Integrated Title Generator
- 32-bit processing (24-bit color and 8-bit alpha channel).
- Support for TrueType fonts and international character sets.
- Drop shadows, transparency and color blends.
- NTSC and PAL-safe color palettes.

Media Management
- Media library for organizing digital clips.
- Database with search capabilities.
- Customized views for easy clip access and retrieval.

QUICK DIAL 731

TRUEVISION

TARGA1000/2000

Digital Video Capture Boards for Windows, Windows NT and Macintosh PCI

The TARGA 1000 and 2000 are an easy and affordable way to transform your computer into a powerful digital editing system. Along with their high-speed PCI interface, both the TARGA 1000/2000 incorporate all you need to create spectacular multimedia content. They support NTSC and PAL standards and let you capture, edit and playback full-motion, full-resolution digital video with fully synchronized CD-quality audio. Designed for high performance IBM compatibles and Power Macs they deliver incredible processing speed for video and audio effects, titling and compositing.

TARGA 1000/2000 PCI for Mac is the premier open systems (QT 2.1 Native) video capture/playback and effects acceleration board on the market. They provide a flexible "plug-and-play" solution for video authoring, 3D animation and multimedia applications. Work on animation projects with software like Strata Studio Pro or Specular Infiniti-D and video or CD-ROM authoring with Adobe Premiere and After Effects 3.0.

Advanced DVR (Digital Video Recording) Technology:

The TARGA 1000/2000 employ advanced DVR technology to deliver superior video performance. Unlike other systems that treat each frame of video as a block of data tied to a specific order of steps such as decompression-resize -compress-write to disk, DVR writes an entire frame of uncompressed video to the huge on-board 20 MB RAM buffer of the TARGA 2000 (8 MB RAM buffer of the 1000.

This is a "memory-centric" approach, in which all board functions share access to the video buffer. For example, a DSP (digital signal processing) chip can scan for additional data, such as matching audio samples to video frames to help maintain lip sync. Transitions, filters, effects and/or resizing can also be applied while the uncompressed frame is in TARGA memory. The final output is then compressed and written to disk. Video data only crosses the bus twice –both times in compressed form. On other systems, the video data path is longer and more complicated. Video crosses the bus–twice uncompressed and twice compressed.

The DVR architecture can access information in its memory buffer at a speed of 230MB per second. Video runs only at 2 to 7 MB per second, so the TARGA boards have all the time needed to decide what to do with each frame. And because uncompressed data is never sent across the bus, bottlenecks that plague other systems are eliminated.

TARGA 1000/2000 Features:
- Record and playback video directly to/from hard drive at full motion, full frame rates (50 fields/sec –PAL, 60 fields/sec–NTSC). Video is stored and played back at the highest resolution for each format (768 x 576 x 24 bit –PAL, 640 x 480 x 24 bit –NTSC). Compression can be adjusted on the fly to optimize for image quality and/or minimum storage space.
- Audio is digitized at 44.1KHz or 48KHz sampling rates, for professional quality stereo sound. Since all audio and video processing is done by on-board DSPs, you are assured of perfectly synchronized sound and images.
- Equipped with composite and S-video inputs/outputs. Also available with component input/output (TARGA 1000 PRO).
- Genlock using separate sync input for working in professional video suites
- Optimized to work with Winsows NT-based software (Adobe Premiere 4.2, in:sync Speed-Razor MACH III)

Macintosh version only:
- Video capture plug-in for Adobe Photoshop.
- Quicktime 2.1 compatible, can be used directly out of the box with many applications.

TARGA 2000 Additional Features:
- Accelerated Windows 3.11 and Windows NT 3.51 display drivers offer integrated, true-color (24-bit), non-interlaced desktop up to 1152 x 870 pixels.
- View your desktop and video-in-a-window on your non-interlaced monitor while the processed video is output at NTSC or PAL to a video monitor and/or a VCR.
- Provides a large work area for displaying video, as well as editing application controls. Any part of the display (or even the whole image) can be recorded to tape (video-out-of-a-window).
- Equipped with composite and S-video inputs/outputs Also available with component input/output (TARGA 2000 PRO)

TARGA 1000 for Windows or Macintosh PCI (specify) 2595.00
TARGA 2000 for Windows or Macintosh PCI (specify) 3995.00
Special! TARGA 2000 for EISA (PC) or Nubus (Macintosh) (specify) 2495.00

NEW! TARGA2000 RTX

Truevision's most advanced digital solution, TARGA 2000 RTX features a breakthrough architecture to deliver broadcast quality video and *real-time effects* processing on the desktop. It provides input and output connections through an advanced breakout box, works in Windows NT or Mac OS environments and can drive an 21-inch RGB monitor at 24-bit color. It also supports full-motion previewing on both RGB and video monitors. The 2000 RTX installs in a single PCI slot, and it plugs directly into the breakout box. The box can be rackmounted or utilized as a stand-alone device on your desktop. It allows easy connection to your input and output cables for composite, component and S-video as well as XLR balanced audio, genlock and alpha channel.

- QuickTime and Video for Windows Native lets it work with a large number of off-the-shelf video applications
- Dual Motion JPEG Codec Architecture processes 2D digital effects in real-time
- Breakout box with component I/O and balanced XLR audio for integration into post-production environments.
- Alpha channel output supports downstream luminance and chrominance keying.
- Delivers near lossless broadcast quality video to your desktop (up to 9 MB's per second (300KB per frame)
- CCIR 601 and Square Pixel support

TARGA 2000 RTX boards are only available outside of N.Y. area in complete turnkey systems. See next page.

While other off-the-shelf video authoring applications can be used with the TARGA 2000 RTX, only one takes advantage of its two streams of video and only one performs effects in realtime..........

SPHEREOUS

It empowers your TARGA 2000 RTX to do exactly what it's meant to do.

Working in perfect harmony with the RTX hardware, SPHEREOUS software takes your video productions to new heights. It lets you see your creativity the minute it strikes. In fact, everything SPHEREOUS does is realtime.

- The RTX dual codec provides SPHEREOUS with two simultaneous streams of video. So all the value-adding effects that are spinning and swirling in your mind can come to life–immediately.
- Realtime effects include wipes and fades, dissolves and digital video effects. There is also realtime audio panning and mixing, plus the ability to create unlimited custom effects. The sky is the limit.
- The easy-to-use SPHEREOUS interface will have you and up and running right away. Many functions are completely intuitive so there is no need for lengthy training courses. Just plug it in and start editing. Readily available on-line help further simplifies the process.
- SPHEREOUS gives the ability to access and exchange media freely– allowing members of a creative team to realize the full potential of the digital convergence.

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A note about our turnkey systems:

In addition to the systems listed on this page, we can further customize any system to fit particular needs. You can choose faster display cards, bigger hard drives, more memory, larger monitors, better speakers, etc. We also carry a large variety of 2X and 4X CD-ROM writers (HP SureStore 4020I, Sony Spressa, FWB Hammer CD-Rs), RAID subsystems (Optima, FWB), portable storage devices (Iomega, Syquest) to name a few. Tell us what you need and our salespeople will custom-design a system for you. And if you happen to be in New York, please come and . . . ***Visit our expanded Video Store and Digital Video Showroom***

QUICK DIAL 731

DIGITAL PROCESSING SYSTEMS INC.

PVR-2500 'Perception' Digital Video Recorder

The Heart of an Advanced Digital Audio/Video Workstation

The PVR-2500 offers powerful features for awesome animation, morphing and rotoscoping capabilities. With features like 720 x 480 resolution, 10-bit 2x over-sampled video encoding, better than D1 scaling, component and S-Video outputs, multi-processor support and integrated FAST SCSI-2 controller, it empowers your computer to rival the finest professional production studios.

- The PVR-2500 is a full-length PCI card with a FAST SCSI-2 controller which connects to one or up to seven dedicated hard drives. Because the SCSI controller is integrated with the PVR-2500, video data never has to go over the PCI bus during playback. This avoids the bottlenecks found in systems which use the computer's hard drive for video storage.
- Perception gets animations out of your computer fast and easy. Its exclusive multi-format virtual file system ensures complete integration with your Windows NT applications. Any acquired video or computer generated Perception video clips appear simultaneously in many different file formats including TARGA, SGI, BMP and IFF. Perception is compatible with Lightwave 3D, Autodesk 3D Studio Max, Crystal Graphics TOPAS 5.1 PRO, Microsoft SoftImage, Elastic Reality and others.
- Runs under Windows NT 3.5 on computers with Pentium, DEC Alpha or MIPS processors. Perception's software utilizes NT's native support for multitasking and multiple processors, allowing use with the most powerful computers.
- Perception performs real-time interpolation of 30 fps video to 24 fps film rates or vica versa. This means that it is also at home on the Hollywood movie set as well.
- Video output section utilizes 10-bit 2x oversampled encoding and provides broadcast quality CCIR-601 (720 x 480) resolution. Dynamic range is in excess of D1 scaling so images are brighter, have more color and greater spatial resolution than ever before. Component, composite and S-Video outputs are provided via the included breakout cables.
- Also control BVU protocol VCRs for video acquisition. VCR-like controls on the Perception's GUI simplifies the task of batch digitizing and recording. In this mode, the PVR-2500 can read SMPTE time code from the source deck.
- Can be used with any Windows NT compatible sound card while synchronization of audio and video is maintained by the PVR software. Captured audio is stored on the computer's system hard drive, not on the dedicated drives. This approach provides maximum flexiblity for manipulating audio and video during editing.
- Can be used with third party editing software such as Adobe Premier or in:sync Speed Razor MACH III. In fact, a system equipped with the PVR-2500, AD-2500 capture card, a sound card, editing software & one or more SCSI drives becomes a non-linear editor of unparalled performance – at an unbeatable price.

Bundled plug-in for Kinetics 3D Studio MAX

Every PVR-2500 includes DPS Lockstep software to provide significant control over 3D Studio MAX

- Frame buffer device rendering mode enables unlimited test renders without having to delete files.
- Easily control PVR parameters like preview sizes and pencil test options from within 3D Studio MAX. Device level support automatically sets screen size, aspect ratio, gamma, and other related PVR adjustments.
- Video, animations and stills on the PVR SCSI drive show up as PVDs or PST's within MAX dialog boxes.
- Image selection, background and video post tools in MAX work like standard video streams.
- PVR image sequences show up in the viewports and shuttle with the frame selector bar in MAX.
- Offset and editing tools work natively.
- No more jumping out to the PVR Player or file manager. Lockstep provides direct support for selecting, playing, deleting and managing the PVR disk and files.
- By setting one check box in the rendering dialog, all network rendering machines can render directly to the PVR-2500 while maintaining the correct frame order. It couldn't be any easier.

AD-2500 Component Video Capture Card

Coupled with the AD-2500 live video capture daughter card, the PVR-2500 becomes a broadcast-quality digital disk recorder. It delivers unsurpassed picture quality and storage capacity is limited only by the size/number of attached SCSI hard drives.

- Has component, composite and S-Video inputs for real-time recording. Captured video can also be exported as sequential RGB files for rotoscoping and other compositing applications.
- Incorporates a sophisticated automatic entropy prediction circuit that analyzes the content of incoming video and dynamically calculates the optimum amount of compression on a field-by-field basis—even during real-time recording. You also have complete manual control over compression level/quality settings.

FX-2500 Perception Effects Accelerator

The FX-2500 significantly reduces the time required to render complex non-linear transitions. Although it doesn't deliver real-time transitions, it significantly improves the productivity of non-linear editing systems by dramatically speeding up the rendering time for many effects and transitions.

- A stand-alone PVR-2500 provides real-time cuts between video clips, but other transitions such as dissolves and wipes, substantial delay can occur. A 30 frame dissolve can take minutes to render, even with the fastest PC, because the host CPU processes source frames on a pixel-by-pixel basis. The Perception F/X reduces the waiting to time to under 10 seconds.

DAR-2500 Digital A4V Recorder

Featuring comprehensive audio post-production capabilities, the A4V (Audio for Video) board provides perfect video/audio synchronization when used with the PVR-2500. A full-length PCI card, the A4V's input and output connections are made via the supplied breakout cables while digital audio is stored on the system hard drive. And to ensure compatibility with third-party audio editing software, it plays and records standard uncompressed WAV files. It can also be controlled directly by video editing software like in:sync's Speed Razor Mach III.

- Non-linear, non-destructive audio editing. No waiting for edits to compile.
- True audio scrub.
- Simultaneous record/playback. Play up to three stereo tracks while recording one stereo track.
- Mix four stereo source tracks down to two output channels in real-time.
- Four-band Parametric EQ for each channel (assignable by stereo pair).
- Real-time reverb and compressor/limiter. Additional effects can be easily added via software upgrades.
- Built-in LTC/ VITC time code generator/reader/inserter lets you create window dubs with time code information superimposed over composite or S-video signals.
- Unlimited audio editing capabilities with third party software.

DPS HOLLYWOOD

Uncompressed 10-Bit D1 Video Disk Recorder

Hollywood is a PCI and ISA-based three card set that provides a D1 video recording solution for high-end animation, rotoscoping, and video/graphics compositing. Because such operations can require many passes, Hollywood avoids the use of any video compression which can progressively deteriorate images.

- Hollywood dramatically reduces the cost per minute for uncompressed video recording. Equipped with 4GB hard drives, typical Hollywood recording times range from 7 to 10 minutes. Compare the cost of Hollywood against competitive products which provide mere seconds of capacity.
- Equipped with serial D1 and component analog video (Betacam/MII) inputs as well as composite and S-Video.
- Optional SD-2500 Serial D1 I/O option lets you interface the PVR-2500 directly to Hollywood. The SD-2500 provides one serial D1 input and two outputs plus a composite input.
- Can also function as a digital test signal generator, providing 20 different 10-bit digital test patterns.

PVR-2500 Digital Recorder	1599.00
AD-2500 Video Capture Card	849.00
FX-2500 Effects Accelerator	899.00
DAR-2500 Digital A4V Recorder	1295.00
Hollywood 10-bit Video Disk Recorder	CALL
SD-2500 Serial I/O Card	CALL

TARGA 1000/2000 and DPS PVR-2500 Windows NT 3.51 Turnkey Systems:

- Video capture board (specify) • 220-watt, 6-bay midtower case
- PCI motherboard with 512K pipelined burst cache
- Pentium 166 MHz processor
- 9FX Motion 771 2MB VRAM PCI display card (TARGA 2000 Systems only)
- 9FX Motion 771 4MB VRAM PCI display card (DPS and TARGA 1000 Systems only)
- 32MB of EDO (Extended Data Out) RAM (Premiere systems only)
- 64MB of EDO RAM (Real Impact and Speed Razor systems only)
- Quantum 1.28GB IDE system drive
- Seagate (Barracuda) 4.2GB SCSI-2 FAST/Wide hard drive
- Adaptec AHA-2940UW FAST/Wide SCSI-2 controller card
- MediaTRIX AudioTRIX Pro DSP-equipped 16-bit audio card (for DPS systems only)
- 3.5" floppy drive • Teac CD-58e 8X EIDE internal CD-ROM drive
- Altec-Lansing 300.1 three-piece deluxe speaker system
- Princeton Ultra 17+high resolution 17-inch multiscan monitor
- Focus 2001A keyboard • Microsoft MS mouse • Windows NT 3.51 operating system software.

TARGA 1000/Adobe Premiere 4.2	$7495	TARGA 2000/in:sync Speed-Razor	$10,695
TARGA 1000 PRO/ Adobe Premiere 4.2	$7795	TARGA 2000 PRO/in:sync Speed-Razor	$11,395
TARGA 1000/in:sync Speed-Razor MACH 3.5	$8995	TARGA 2000/AVID Real Impact	$10,995
TARGA 1000 PRO/in:sync Speed-Razor MACH 3.5	$9295	TARGA 2000 PRO/AVID Real Impact	$11,695

*PVR-2500/AD-2500 w/Adobe Premiere 4.2 .... $7495 *PVR-2500/AD-2500 w/in:sync Speed-Razor .. $8695
*PVR-2500 System Notes: 1) Does not include Adaptec SCSI-2 controller card (has built-in SCSI-2 port)
2) Includes Seagate Barracuda 4.2GB Narrow hard drive (doesn't accept Wide drives)

Expansions and Upgrades for all Systems:

Full Tower Case (10-bay)	add 100.00
Super Tower Case (12-bay)	add 200.00
Pentium Pro motherboard and Pentium Pro 200 MHz processor (256k cache)	add 800.00
9FX Motion 771 4MB VRAM PCI Display Card (for TARGA 2000 systems only	add 200.00
Seagate Elite 9.1GB Narrow drive (for DPS)	add 1000.00
Seagate Elite 9.1GB Wide drive	add 1000.00
MAG Innovision MXP-17F 17" multiscan monitor	add 225.00
MAG MXP-21F 21-inch multiscan monitor	add 1100.00

MEDIA 100 — DATA TRANSLATION Media 100 qx

Media 100 qx is a high-performance digital video system that lets users of QuickTime-based applications create professional broadcast-quality video programs. It combines industry- leading image and audio quality with the industry's most popular editing program– Adobe Premiere. The result is broadcast -quality programs indistinguishable from Betacam –at an affordable price. Media 100 qx lowers the cost traditionally associated with digital video systems. Plus it offers an easy, software- only upgrade path to the advanced features and real-time functionality of professional Media 100 systems.

BROADCAST-QUALITY VIDEO:
Media 100 qx is based on Vincent, the same digital engine used in the professional Media 100. Vincent is a single-card designed specifically for Power Macintosh systems with PCI bus. In fact, by using Vincent, Media 100 qx delivers image and audio quality indistinguishable from what thousands of professional Media 100 users get everyday. True broadcast quality not available with any other QuickTime–based video editing product.

OPERATES IN YUV COLOR SPACE:
Vincent is a true video processing card that processes video signals in YUV color space avoiding the quality degradation inherent in RGB conversion. Media 100 qx also supports component video (Media 100 qx Component). This version brings broadcast-quality Y, R-Y, B-Y video input and output to Media 100 qx

FAST RENDERING:
Power of the Vincent board increases your productivity by accelerating the rendering of 20 of the most popular effects.

OPEN SYSTEM FOR UNLIMITED OPTIONS:
An open system Media 100 qx is fully compatible with Power Macintosh hardware and off-the-shelf software. Open system design also means that you have a common interface and transparent access to QuickTime applications.

WORK WITH QUICK-TIME APPLICATIONS:
Media 100qx runs seamlessly under QuickTime, providing communication between Media 100 qx and hundreds of QT applications such as Adobe Premiere and After Effects 3.0, Specular Infini-D, Strata StudioPro and Macromedia Director. QT integration lets you "drag and drop" files between multiple applications with no loss in quality.

MEDIA 100 COMPATIBILITY:
Provides a software-only upgrade to the real-time editing functionality of the high-end Media 100. Clip media and programs authored on Media 100 qx can be used directly by any Media 100 system with no data loss. Drag and drop files from one system to another.

PLATINUM ONE-STOP SUPPORT SERVICE:
The most comprehensive service and support offerings in the industry. Choose from a full range of options including, unlimited toll-free telephone support, exchange loaner program, extended warranty and All-in-One Protection.

SPECIFICATIONS:

- All digital, on-line video quality with data rates up to 200 KB/frame –equates to 6.0 MB per second
- Full-screen, full-motion video capture and playback at 30 fps (60 fields) NTSC and 25fps (50 fields) PAL
- Composite and S-video input and output. Also available with component input and output (Media 100 qx Component)
- Uses standard high-performance Mac SCSI drives
- Genlock output for integration with pro systems
- Clips compressed at different rates within a single program
- View or record 32-bit animation to tape in real time
- Playback of eight tracks of real-time audio
- 16-bit CD/DAT-quality audio input/output
- Balanced XLR connectors (with component version)
- Audio simultaneously captured and synched to video
- 20 accelerated wipes and dissolve effects

Media 100qx and TARGA 2000 Power Mac Turnkey Systems

- *Power Mac 8500 (256K cache) or 9500 (512K cache)*
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- *Apple 8X Internal CD-ROM Player*
- *2GB FAST SCSI-2 System Hard Drive*
- *Optima DisKovery 8200 8.2 GB Dual Channel Disk Array*
- *AppleVision 1710AV 17-inch monitor with built-in speakers*
- *Adobe Premiere 4.2 (Media 100 qx systems only)*
- *Scitex SHEREOUs Realtime Editing Software (TARGA 2000 RTX systems only)*

Power Mac 8500/180 with Media 100qx	12,500.00*	Power Mac 8500/180 with TARGA 2000 RTX	19,750.00
Power Mac 9500/200 with Media 100qx	12,750.00*	Power Mac 9500/200 with TARGA 2000 RTX	19,995.00
Power Mac 9500/180 MP with Media 100qx	13,500.00*	Power Mac 9500/180 MP with TARGA 2000 RTX A	20,750.00
For systems with Media 100 qx Component*			add $1500

**Purchase a Platinum One-Stop Technical Support contract for the Media 100 qx until 10/23/96 and receive a free software upgrade to the new Media 100 le. A feature set below the full-blown Pro Media 100, the new Media 100 le offers realtime non-linear editing, realtime editing of 4-track CD-quality audio, realtime audio node adjustment during playback and single-track audio cross dissolves, alpha channel support and FastFX: accelerated dissolves and wipes 399.00*

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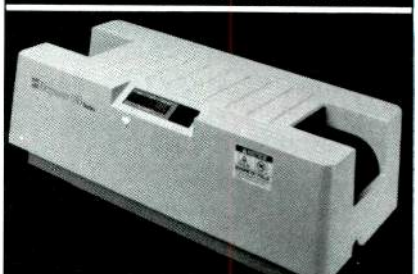

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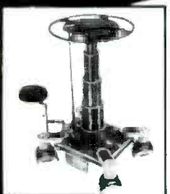

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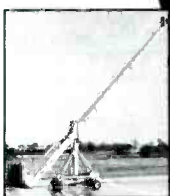

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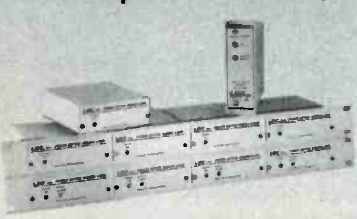

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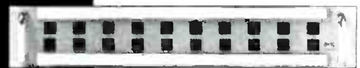

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AD INDEX

	Page Number	Reader Service Number	Advertiser Hotline
Acrodyne Communications Inc.	49	22	800-523-2596
ASACA/Shibasoku Corporation	60	38	310-827-7144
ASC Audio Video Corporation	67	44	818-843-7004
Audio Precision	7	11	800-231-7350
Avid Technology	9	12	800-949-2843
Avitel Corporation	72	47	801-977-9553
Beck Associates	109	102	512-388-9777
Belden Wire & Cable	36	20	800-235-3364
B&H Photo - Video	105-107	60, 61	800-947-9928
Broadcast Video Systems Ltd.	88	58	905-764-1584
Canon USA Broadcast Lens	19	8	201-816-2900
Clear-Com Intercom Systems	101	66	510-527-6666
Comark Communications, Inc.	79	51	215-822-0777
Conex Electro Systems	76	42	360-734-4323
DNF Industries	101	64	818-252-0198
ESE	83	56	310-322-2136
Fujinon, Inc.	23	15	201-633-5600
Garner Industries	108	101	800-228-0275
Gentner Communications	3	5	800-945-7730
Harris Corp./Broadcast Div.	1, 75	4, 41	606-282-4800
Henry Engineering	62	28	818-355-3656
Herman Electronics	101	65	305-477-0063
HHB Communciations Limited	103	59	+081-960-2144
Hitachi Denshi America	51	24	516-921-7200
Hoodman Corporation	108	100	310-379-6391
Ikegami Electronics Inc.	81	55	201-368-9171
Illbruck	99	53	800-662-0032
Interbee/Jesa	63	29	+81-3-5402-7605
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Jampro Antennas, Inc.	28	18	916-383-1177
Ledtronics, Inc.	38	31	310-534-1505
Leightronix Inc.	101	63	517-694-5589
Leitch Incorporated	BC	3	800-231-9673
Louth Automation	53	35	415-843-3665
Maxell Corp. of America	11	13	800-533-2836
Mohawk/CDT	74	49	508-537-9961

	Page Number	Reader Service Number	Advertiser Hotline
MountainGate	69	45	800-556-0222
Multidyne Electronics	100	54	800-4TV-TEST
Myat	101	62	201-767-5380
OConnor Engineering	52	25	714-979-3993
Odetics, Inc.	27	17	800-243-2001
Opamp Labs, Inc.	76	43	213-934-3566
Orban	57	36	510-297-2774
Allen Osbome Assoc.	66	40	805-495-8420
Panasonic Broadcast & TV	40-41		800-524-0864
Philips Broadcast Television Systems Company	5	10	800-962-4287
Quantel Inc.	13	6	203-656-3100
Research Technology Intl.	91	52	847-677-3000
Sachtler Corp. of America	29	9	516-867-4900
Sanix Corporation	87	57	708-677-3000
Sierra Video Systems	71	46	916-478-1000
Snell & Wilcox Ltd	15-17	7	408-260-1000
Snell & Wilcox Ltd	45-47	21	408-260-1000
Snell & Wilcox Ltd.	58-59	37	408-260-1000
Sony Business & Professional	34-35		800-635-SONY
Sony Business & Professional	54-55		800-635-SONY
Standard Communications	61	26	310-532-5300
SyntheSys Research Inc.	73	48	415-364-1853
TDK Electronics Corp.	43	34	800-TDK-TAPE
Tektronix Inc./Grass Valley	37	30	800-998-3588
Tektronix Inc./Profile	39	32	800-998-3588
Tele-TV Systems	62	27	703-810-1796
Utah Scientific	21	14	800-453-8782
Video Media Inc.	50	23	408-227-9977
Videotek, Inc.	IBC	2	800-800-5719
Vinten TSM	77	50	914-268-0100
Wegener Communications	25	16	404-623-0096
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By Paul McGoldrick

Packet video

Discussions about "packet video" are likely to conjure up exotic transmission schemes; schemes that may be in place when future generations send video data into outer space. Thinking about it, you will realize that all the video we have dealt with is packet video: line periods are fixed packets of time, as are field and frame periods. Composite and component video are packet video streams; in these cases, the packets are time-defined and have no dependence on the video signal amplitudes, the picture content. In between these packets of video information is synchronizing information: line timing, field timing and color phasing.

When more than one signal is required on the same channel, the integrity of the packets is maintained by timing all the signals to be synchronous. That is, achieved either with hard-cable wiring lengths, genlocking or with frame synchronizers. The required buffering effects of the synchronizer are at the cost of introducing time delays (or, to be more politically correct, "latency") through the unit, and it is important to remember that similar delays must be included in the audio chain (for lip sync).

Digital packets

Video and audio are still packetized in the digital world; there are 8- and 10-bit words for video (and my guess is we'll be discussing or using 12-bit words within five years) and 16-, 20- and 24-bit words for audio; all packetized, even if the packets are relatively large, with constant sampling frequencies and structures.

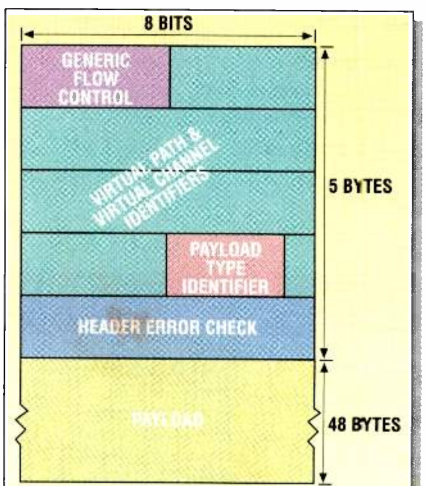

Figure 1. Simplified structure of the 53-byte ATM cell.

As we progress in the digital world, there are changes to the rigid structures we have seen. Movement is away from real-time processing and there are different compression schemes or ratios, non-linear recording and editing, statistical multiplexing and the like. The latter is perhaps not yet well-known: statistical multiplexing is being suggested and commercialized for more efficient accommodation of a group of compressed signals on a single satellite transponder. Instead of allocating the same proportion of the bitstream to each channel, the multiplexer varies the compression ratio according to the picture content in each channel.

The constant bitstream is going to be a constant desire, and perhaps requirement, for many of the packet schemes in the future. MPEG and JPEG are packet video schemes, so are standard storage files for video, such as TIFF. But perhaps the most interesting potential video packet scheme is Asynchronous Transfer Mode (ATM).

ATM packets

Ask about the possibility of carrying video on ATM and you will probably get as many answers as the number of people you ask. The ATM standards — and that is considered a rather loose term in some societies — are certainly one of the worst compromises ever to be called standards, with just about everybody unhappy.

For the common carriers, the problem is in the perceived latency of the system, a customer no-no since the first satellite delays in calls across the Atlantic. The ATM cell is 53 bytes in length (see Figure 1), with 48 bytes of it being payload. For duplex audio this is close to non-acceptable. For simplex video, the latency is probably immaterial for most applications, but in distributed ATM systems, there is a delay variation that is unpredictable. In an Internet situation, if there is a problem in a circuit, signals will be re-routed at the switchers. The queues that are encountered and changes in switching schedules cannot be forecasted. There is also cell "clumping" (the equivalent of a digital freeway backup) at the interface between the ATM and the physical layers.

Experience shows that given an arrival time window (and a window must be fixed for cost reasons), which will be a fixed delay plus a variable, there will be success cells, errored cells (but delivered within the window), lost cells (outside the window) and "not ours" cells. Add to that the fact that the tolerable cell delay variation for MPEG-2 is about 1ms and the transport stream of 188-byte packets must be broken up for ATM. As you can see, the question of video over ATM is at best "hairy." ■

Paul McGoldrick is a freelance writer and consultant based on the West Coast.