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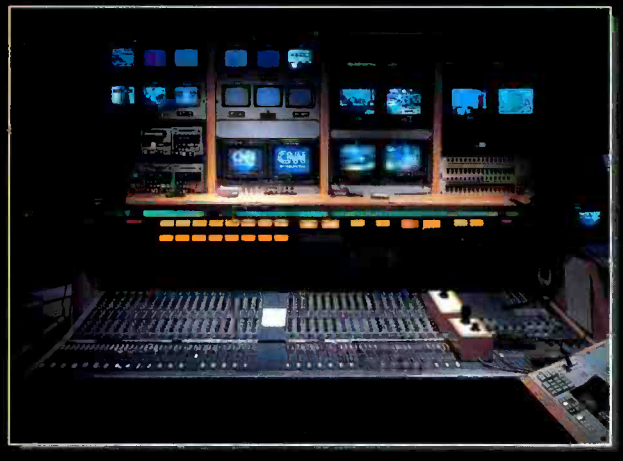

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ON THE COVER:
Video storage has come a long way since the days of 2-inch quad tape. Today's fast-paced video production environments need instantaneous access to source material. The Quantel Clipbox is shown on the cover. (Cover design courtesy of Quantel.)

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By Dawn Hightower, senior associate editor

Sony develops flat panel display

Sony Corporation has developed a flat panel display for large-screen use tentatively called the PLASMATRON. The display is based on Plasma Addressed Liquid Crystal (PALC) technology jointly developed with Tektronix. The display features high-brightness, high-contrast and clear picture quality. Sony plans to introduce PLASMATRON sometime in 1996 in Japan.

The display is an active matrix system that separately addresses each pixel of the liquid crystal. The address method is based on PALC technology, which uses plasma as an electronic switch. The backlight, which is independent of the panel, is used as the light source to reproduce a picture with high brightness. Each single scanning line corresponds to a single plasma channel. The picture is composed of about 450 plasma channels.

To facilitate the multilayer printing process needed in producing the panel's plasma address board, Sony developed a high-precision screen-printing technology. Because the screens can be produced in low-grade clean rooms rather than semiconductor facilities, the manufacturing process is simpler, resulting in higher yield rates and lower costs.

EIA/ATV Committee urges universal access to HDTV broadcasting

Although the Advanced Television Committee of the Electronic Industries Association (EIA/ATV Committee) supports many of the viewpoints of the Broadcasters' Proposed TV Allotment Assignment/Approach filed with the FCC in January, the committee has urged the commission to require broadcasters using the ATV channel to provide universal access to HDTV.

The EIA/ATV Committee feels that now is the time to develop a table of allotments and assignments for VHF and UHF channels. In accordance with the broadcasters' proposal, the FCC should adopt this timetable at the same time it adopts ATV transmission standards. This will give broadcasters, manufacturers and programmers the incentives and tools to implement ATV.

Although broadcasters should be accorded flexibility in their use of ATV spectrum, the committee maintains that it is essential for HDTV to be the centerpiece of the FCC's ATV policies. If the FCC is to achieve its ATV policy goals and ensure that the additional spectrum made available is used in the public interest, broadcasters should be required to transmit a minimum amount of HDTV broadcasting each day. Alternatively, the commission may wish to pursue a policy that gives broadcasters an incentive to transmit HDTV programming by assigning additional spectrum only to those licensees that demonstrate a commitment to HDTV.

SCTE issues call for papers

The Society of Cable Telecommunications Engineers (SCTE) is seeking abstracts for technical papers. The papers will be presented at SCTE's 1996 Conference on Emerging Technologies Jan. 8-10 in San Francisco.

Topics will include digital compression and transmission, telephony, multimedia and future technologies. Those interested in presenting papers should contact Roberta Dainton at SCTE by calling 610-363-6888 or via fax at 610-363-5898. Submissions are due by Sept. 1 and should include an abstract of the proposed paper.

New Orleans to sponsor World Media Expo '95

New Orleans is the site for the 1995 World Media Expo Show and the SBE/NAB Broadcast Engineering Conference that will run from Sept. 6-9.

The SBE, in cooperation with NAB, will present three days of seminars on various equipment and services important to radio and TV stations. The one-day Ennes Workshops will precede the conference on Sept. 6. The workshops are available for an extra fee and are open to full-paid conference registrants. Registration is on a first-come, first-served basis, and you must pre-register for the Ennes Day.

The Broadcast Engineering Conference is the heart of the seminar schedule. Sessions will focus on regulatory issues, including EAS, unattended operation and FCC/FAA considerations; digital technology for television; RF technology for television; tower design; and safety and liability considerations.

Registrants for the SBE Program are invited to attend the opening reception on Sept. 7. The Ham Radio Reception is Sept. 8, and the awards banquet is Sept. 9.

SMPTE sponsors compression tutorial

The Rochester section of the Society of Motion Picture and Television Engineers (SMPTE) is sponsoring a one-day tutorial compression seminar on Oct. 28. "The Compression Experience" seminar will be held in Rochester, NY, at station WXXI. The morning will be devoted to fundamentals and the theory of digital compression. The afternoon session will focus on digital compression applications for moving pictures and sound.

For SMPTE members, the cost of the one-day event is $35 for advance registration, which includes lunch. Registration after Oct. 2 and at the door will be $50.

Non-member advance registration is $50 but after Oct. 2 and at the door will be $65. Student advance registration is $20 or $25 after Oct. 2.

Inquiries and requests for a registration form should be sent to Tom Hope, 58 Carverdale Drive, Rochester, NY 14618-4004 or faxed to 716-442-1310.

Pixar Animation president to deliver SMPTE keynote address

Edwin E. Catmull, president of Pixar Animation Studios in Richmond, CA, will be the speaker at the opening session of the 137th SMPTE Technical Conference and World Media Expo on Sept. 6 in New Orleans.

Catmull created one of the first computer-generated animation effects for film. He has won three Academy Awards for his company's work with computer graphics and motion imaging on major motion pictures.

The opening session, including the keynote address, is free to all full conference registrants to the SMPTE, NAB, SBE and RTNDA conferences. The session will be held in Meeting Room 42 of the New Orleans Convention Center on Sept. 6.

For more information, contact the SMPTE Marketing Department at 914-761-1100.

Rocky Mountain Film and Video Expo '95 set for September

The eleventh annual Rocky Mountain Film and Video Expo will run from Sept. 26-28 at the John Q. Hammons Convention Center in Denver.

The expo will feature state-of-the-art equipment, cameras, computers, software, lights and sound recording equipment in addition to several speakers and seminars.

For more information, call ExpoMasters at 303-771-2000 or fax 303-843-6232. ■

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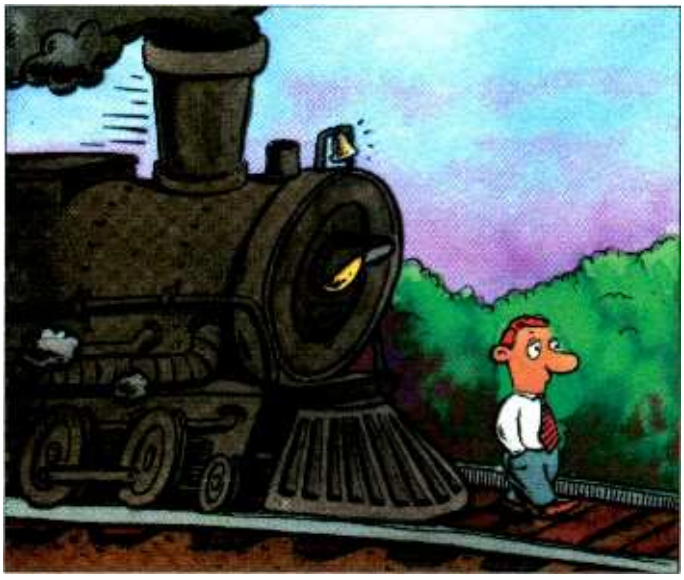
What train?

You country music fans may recall the song that laments those occasions in life when sometimes you're the Louisville slugger and sometimes you're the ball, sometimes you're the windshield and sometimes you're the bug. I recently experienced firsthand what the songwriter may have meant. My analogy was more like that of being hit by a freight train. Not literally, of course, but in a figurative sense. There were times, however, when I would have gladly chosen the literal option.

While struggling to put some perspective on what was going on in my life, I turned to some of my trusted friends and books that have offered me good counsel and advice over the years. For what it's worth, here's some of what I relearned.

One of the most important things I had to rediscover was, as Charlie Brown says, "We need all the friends we can get." In the world of business, it's often easier to make enemies than it is friends. And friends, like plants, need cultivation. When was the last time you called a long-time friend and asked how he or she was doing or planned a lunch date together? If you saw the plants in my office, you'd think I never paid any attention to them. Don't do that to your friends.



I also had to relearn that when business or personal relationships go sour, there are only three ways to make things better:

- Change the situation,
- Change the other person,
- Change yourself.

If the problem is your boss, then changing your job may be the only answer. If the problem is a significant other, then the only solution may be to dump him or her. Tough choices, I know, but let's consider the other two options.

Most of us, especially managers, want to try and change the other person. After all, we're not the problem — the other person or employee is. You can forget trying to change the other person. It doesn't work. How many times have you tried to get those difficult employees of yours (or even your kids) to change their ways? Were you successful? How long did the improved behavior last — two weeks, a month, maybe 20 minutes? Think about it. Would the imposition of someone else's will on you make you feel any better? Heck no. You'd be as mad about them trying to change you as they are about you trying to change them.

Now, I'm as guilty as the next manager (or parent) in this way, and sometimes I attempt to solve problems by trying to get others to "fix" their behavior. Although I'm a slow learner and it took a while, I finally remembered something I learned a long time ago. That is, it's impossible to change people, places or things.

Which returns me to where I began. My life's lesson this month was to relearn one of life's important lessons: Forget trying to change anything but yourself. You are the only thing over which you have any control. Any other approach is guaranteed to fail.

Brad Dick

Brad Dick, editor

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By Harry C. Martin and Andrew S. Kersting

Senate passes telecom reform bill

In June, the Senate overwhelmingly passed the telecom reform bill (S.652). The bill includes amendments to the Communications Act dealing with spectrum flexibility, the elimination of the national numerical cap on the number of TV stations one entity can own, total radio ownership deregulation, a 2-step license renewal process and an extension of radio and TV license terms to 10 years.

The companion bill in the House of Representatives (H.R. 1555) is less deregulatory. It prohibits any entity from owning or controlling two or more TV stations in the same market unless the FCC finds such ownership will not result in a loss of competition or diversity in the market. However, UHF-UHF and UHF-VHF combinations would be permitted unless such ownership results in a loss of competition or diversity.

The House bill would permit the FCC to grant TV license renewals for up to seven years instead of the current five years. The new 2-step renewal process in the House and Senate bill would require the FCC to renew a broadcast license once the agency finds: (a) the station has served the public interest during its license term, and (b) there have been no serious rule violations or patterns of rule violations by the licensee. Applications filed in competition with renewals would not be considered if these threshold public interest findings are made.

The House is likely to vote on H.R. 1555 in August or September. If this happens, a final bill could be sent to the president by Oct. 1.

FCC to speed processing of assignment/transfer applications

The FCC's Mass Media Bureau is operating under a new mandate to reduce the backlog of pending TV and radio assignment and transfer applications. The bureau also will be acting more swiftly on current and new applications and petitions. The accelerated processing procedure is based on a new set of review criteria that will result in the dismissal of frivolous or otherwise baseless petitions to deny or oppositions filed against broadcast applications.

DATELINE: OCT. 1

Commercial TV stations in the following states and territories must file their annual ownership reports or ownership certifications on or before Oct. 1, 1995: Alaska, Florida, Guam, Hawaii, Iowa, Missouri, Oregon, Puerto Rico, Samoa, Virgin Islands and Washington. On or before Oct. 10, 1995, all TV stations must place in their public files their listings of issues and responsive programming for the quarter ending Sept. 30, 1995.

The Mass Media Bureau's initial goal was to resolve all uncontested cases that had been pending for more than 180 days by June 30, 1995. Some of those cases, particularly those that raised novel issues or involved complex facts, had been pending for years. The staff also set July 31 as the deadline to resolve all contested station sales that had been pending for more than 180 days. In order to achieve these goals, the bureau adopted tougher standards concerning:

1) *Jurisdiction* (i.e., whether the FCC has the legal authority to resolve the complaint);

2) *Standing* (i.e., whether the petitioner or opponent has the legal right to file against the applicant);

3) *Remedy* (i.e., whether processing of the assignment/transfer application should be delayed when the likely penalty for an alleged rule violation would be only a small fine).

The staff's new "triage" processing system should result in greater equity and faster service in the assignment/transfer application process.

FCC adopts 1995 regulatory fees

The FCC adopted new 1995 regulatory fees that require each licensee and permittee to pay for each license or permit granted on or before Oct. 1, 1994. See Table 1 for a list of the fees for each type of authorization.

Licensees with auxiliary licenses (e.g., remote pickup stations, STLs, intercity relay stations and low-power auxiliary stations) must pay a $30 regulatory fee for each such license. Licensees of low-power TV, TV translator and TV booster stations whose licenses were granted on or before Oct. 1, 1994, must pay a regulatory fee of $170 per station.

All fees are due on or before Sept. 20, 1995, and must be accompanied by FCC Form 159.

The commission generally has retained the same procedures established in 1994 for the payment of regulatory fees. However, because the time for collecting fees will be limited and regulatees will have at least 90 days' notice of the amount of their fees, installment payments will not be permitted. ■

Harry C. Martin and Andrew S. Kersting are attorneys with Reddy, Begley, Martin & McCormick, Washington, DC.

1995 REGULATORY FEES FOR TV STATIONS

VHF stations		UHF stations	
Markets 1-10	$22,420	Markets 1-10	$17,925
Markets 11-25	$19,925	Markets 11-25	$15,950
Markets 26-50	$14,950	Markets 26-50	$11,950
Markets 51-100	$9,975	Markets 51-100	$7,975
Remaining markets	$6,225	Remaining markets	$4,975
Auxiliary station	$30	Auxiliary station	$30
Construction permits	$4,975	Construction permits	$3,975

Table 1. 1995 regulatory fees for stations.

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EAS update

System overview, part 1

By Paul Montoya

A colleague recently mentioned that he was glad the "BS" has been taken out of EBS. General managers and owners will be happy that their listeners won't be driven away by 22 seconds of obnoxious tones. Engineers will be happy that they don't have to maintain a system that never worked well.

The first phase of the EAS system is already being implemented. These regulations are incorporated into Part 11 of the FCC rules. Before delving into the new system, however, a bit of history is in order.

How we got here

The 2-tone EBS system was established in the early 1970s. This approach provided the most robust way to transmit signals without false triggering. EBS relies on stations passing information from one to another to get the message to the public. This system breaks down often due to a station not passing on information or because of barriers and distances between stations. By the mid-1980s, problems with this system moved broadcasters and the FCC to consider alternatives. A few of those activities ultimately had input to the new EAS. Here are some examples:

The Colorado Broadcasters Association put together a task force to explore delivery of alerting signals around the state. This was a challenge because of the state's topography. The task force came up with a plan using multiple means for point-to-point communications between broadcasters, including microwave and satellite. This *web* approach became the basis of distribution for the system.

Meanwhile, in the Los Angeles area, another engineering group put together a plan for distributing more detailed information about disasters to news departments around the area. Using *packet radio*, the group developed a method of delivering long-form, coded information around the service area.

The National Weather Service also needed a way to reach specific areas through its VHF-based NOAA Weather Radio. Through basic coded information, it came up with a protocol to notify specific populations with multiple alert levels. The system, called *Weather-Radio Specific Area Message Encoder* (WRSAME), serves as the basis for the data protocol found in the EAS system.

In 1993, the FCC began testing new systems with the cooperation of state emergency communications groups in Colorado and Maryland. Testing took about a year.

The FCC then proposed rule changes for the EBS system and after processing comments, it issued a Report and Order outlining the rules in December 1994.

Implementation is the key

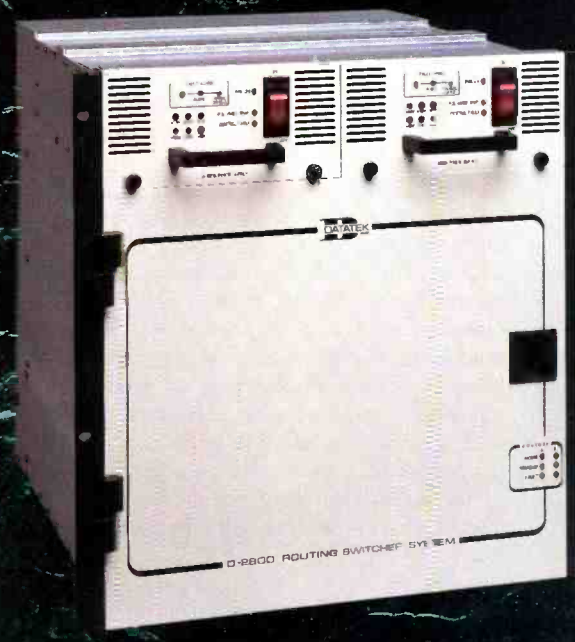
Given the level of effort put into the development of EAS it should work well for many years to come, if implemented properly. But that's a big "if." Its most important component is not at the federal or the state level, but on the local level. This is where EAS will be used most. If the system works well at the local level, then the state and national plans should fall into place easily.

The EAS should be a system that broadcasters will want to participate in if it's put together correctly. A well-implemented EAS can become a valuable resource for the broadcaster rather than simply a new regulatory burden from the FCC.

Next month, this column will explore how the web system works and why this is such an important part of the new EAS. ■

Paul Montoya is president of Broadcast Services of Colorado, a contract engineering firm in Lakewood, CO.

For information on EAS equipment, circle (100) on Reply Card.



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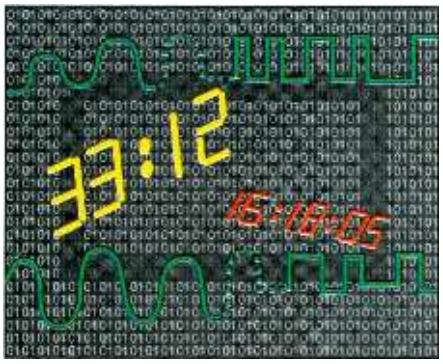
Circle (17) on Reply Card

By Steve Epstein, technical editor



Digital basics, part 1

For those familiar with digital, the early part of this series may seem basic. However, for those beginning to emerge from analog and venturing into digital, this series should provide a solid foundation and a comprehensive source of digital information.

Signal basics

In analog circuits, time-varying voltages (or currents) are used to represent analog light or sound energy (information). In a typical analog circuit, the information represented by the signal and the signal itself are one and the same. Signal amplitude or level can be increased with amplifiers or decreased with attenuators for required signal processing. Equalization (frequency selective amplification or attenuation) can also be used to provide the desired output characteristics. Many times, signal attenuation and/or equalization is an undesired result of signal processing. When this happens, the information represented by the signal becomes distorted.

In digital circuits, information is represented numerically. The signal contains the information, but the information is not directly affected by amplification, attenuation or equalization of the signal. For example, in an analog circuit, a signal level of 5V may represent a 100% amplitude signal and a 0V level represents a 0% amplitude signal. If, due to excessive cable lengths, a 5V signal was attenuated to 3.5V, an analog circuit would interpret it (incorrectly) as a 70% signal level. However, in a digital circuit where signal levels from 0V to 2V represent a "0" and levels from 3V to 5V represent a "1," a 5V signal attenuated to 3.5V would still be interpreted correctly as a "1" at the receiver. In digital circuits, attenuation and equalization may affect the signal, but as long as the numeric values can be correctly recovered, the original information can be reproduced with little or no distortion. To process, in the analog sense, the original waveforms, the numeric representations must be manipulated mathematically.

This is a key difference between analog and digital. Changes to the waveform, whether desired or not, will cause distortion of the information in analog circuits but not in digital circuits. However, gross signal distortions in digital circuits can render it impossible to recover sufficient data to properly reproduce the information. Analog signals tend to degrade predictably, whereas in digital circuits there is no apparent degradation of the information until signal recovery is impossible, at which time all information is lost.

Converting analog to digital

Analog signals are *analogous* to the natural sources they represent. These analog electronic representations must be converted to digital. To convert this information, it must be *sampled* and *quantized*. *Sampling* is the process of measuring signal levels at periodic intervals. According to Nyquist theory, to properly resolve a signal that contains a frequency of x, the signal must be sampled at a frequency of at least $2x$. It follows that to resolve an audio frequency of 20kHz, the *sampling rate* must be at least 40kHz. Common sampling rates for audio include 44.1kHz and 48kHz. For video, sampling rates include 14.3MHz (composite NTSC) and 13.5MHz (CCIR 601).

Aliasing occurs when signals contain frequencies that are higher than half the sampling rate. (See Figure 1.) To prevent aliasing, an anti-aliasing (low-pass) filter is used to remove frequencies higher than half the sampling rate prior to the sampling process.

Quantization is the process of attaching an integer value to the sample. Fractional representations are not allowed. As the range of quantization values is increased, the quantization process becomes more precise. For instance, if a studio lamp is brought up to half brightness and you are asked to represent its brightness level within a quantization range of two (full on or full off), either choice represents a 50% error. If, however, the range was increased to 16, the choice of a seven or an eight would represent an error of 3%. For those that think the middle value would be between eight and nine, digital systems normally refer to the first value as zero, not one. A range of 16 values would start at 0 and go to 15 rather than 1 to 16.

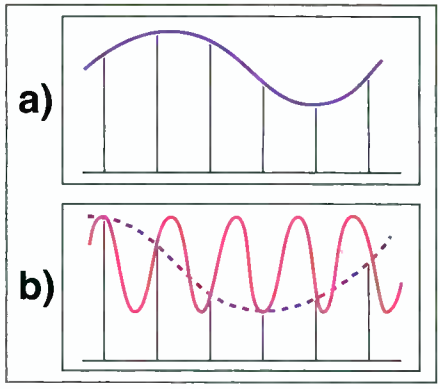


Figure 1. Aliasing occurs when frequencies are sampled using a sampling rate less than twice the signal frequency. In (a) the sampling rate is adequate for the waveform, in (b) the sampling rate is too low. The dashed line shows the resulting sampled waveform.

The choice of 16 is not arbitrary. In digital systems, bits are represented as either zeros or ones. Numeric values of groups of bits follow the powers of two. A group of four bits can represent 16 values or 2^4, eight bits can represent 256 values or 2^8. More often than not, in the future "round numbers" will be powers of 2, rather than powers of 10.

Quantization ranges are chosen based on the amount of storage space available, and balanced with the precision required. A common quantization range for audio is 16 bits, with 8 or 10 bits used for video. For component video, each component may be represented by 8 or 10 bits.

As stations transition from analog to digital, equipment must be chosen carefully to minimize budgeting considerations while ensuring that existing equipment is not rendered obsolete prematurely. (Photo courtesy of Hewlett-Packard.)

Digital video

Numerous standards exist for analog video, unfortunately the same is true for digital video. Luckily, the CCIR-601 standard exists that takes into account the need for converting to/from the various worldwide

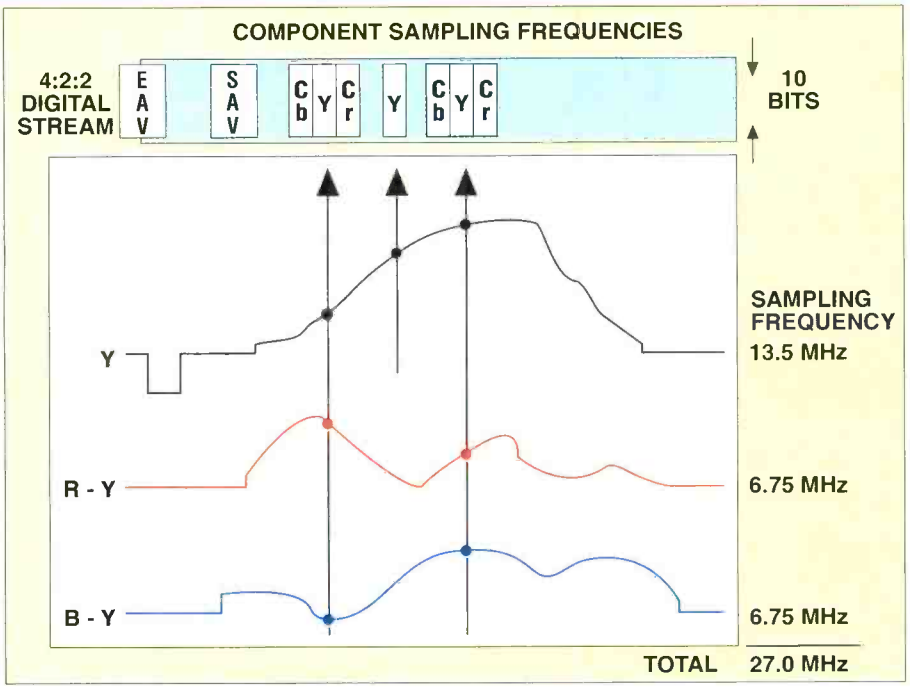
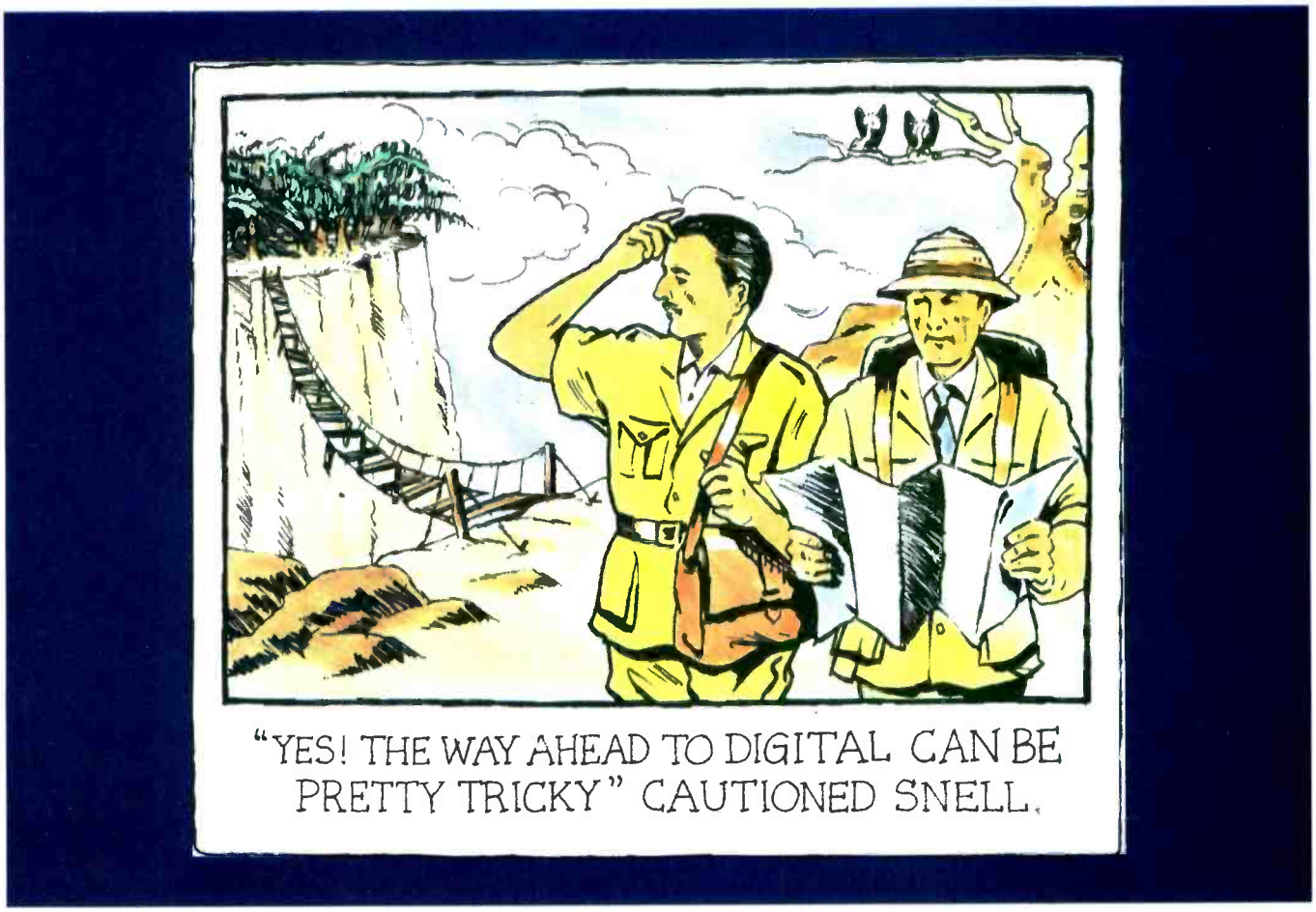


Figure 2. When sampling video for a 4:2:2 digital stream, all three components are sampled, followed by a Y-only sample, then all three samples again.

standards. Like analog, there are composite and component varieties. In addition, the computer graphics world has given us a new group of standard formats to deal with. Let's start with a few basic video signals and deal with the computer graphics world in future columns.

Common digital video types include composite NTSC, sampled at 14.3MHz, using 8-bit quantization. This is the SMPTE 244 specification and is used on the D-2 series of VTRs. A composite PAL standard exists that uses a 17.7MHz sampling rate and up to 10-bit quantization. (For more information on these standards, see "Strictly TV," January and February 1994.) Probably the most common digital format is the CCIR 601 specification. This specification provides for component digital video, sampled at 13.5MHz for luminance with either 8- or 10-bit quantization. If an 8-bit signal is used in a 10-bit system, the eight bits are used as eight most significant bits and the two least significant bits are assumed to be zero.

One common term in digital component video is 4:2:2. Variations of 4:2:2 exist, including 4:4:4, 8:8:8 and 4:4:4:4. All of these numbers refer to sampling rates used with the video in question. In 4:2:2, the luminance is sampled at 13.5MHz (4 x 3.375MHz). The chrominance components, R-Y and B-Y, are each sampled at 6.75MHz (2 x 3.375MHz) (See Figure 2.) In a 4:4:4 system, all three components are sampled at 13.5MHz, resulting in 50% more data. (See Figure 3.) Systems using 8:8:8 use a sampling rate of



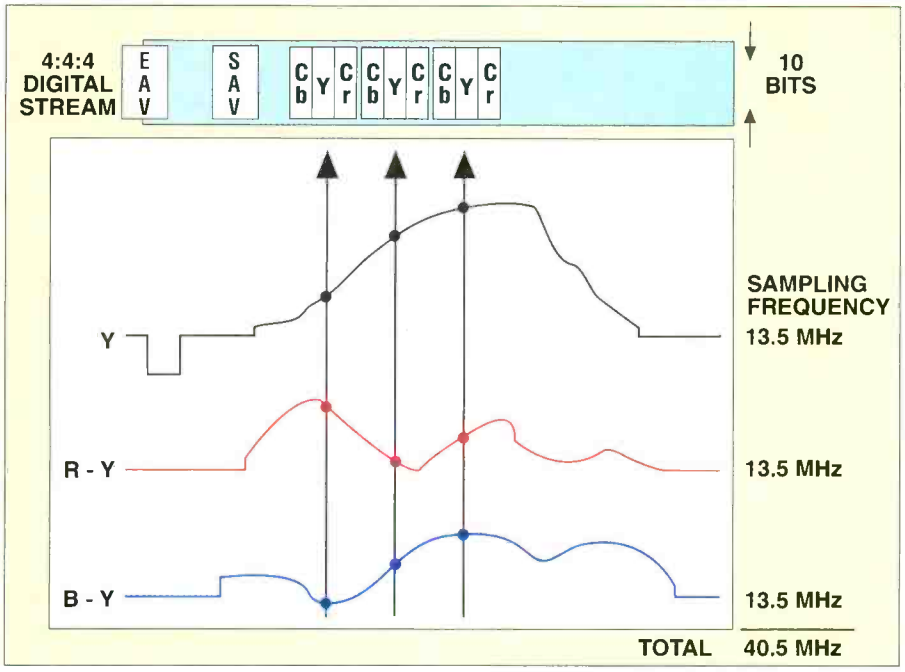
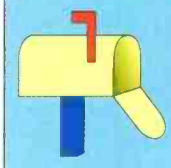


Figure 3. When sampling for a 4:4:4 stream, all three components are sampled every time.

27MHz. The fourth number in the series denotes the sampling rate of a luminance-only alpha channel that is used for keying or compositing purposes.

In component systems, to reduce the number of samples needed, synchronization information is not sampled, but rather, reserved symbols (SAV and EAV) are used to indicate the start of active video and end of active video. When composite video is converted to digital, the sync signal is sampled and included as data in the stream. Unfortunately, this means that quantization levels used to describe the sync pulse reduce the number of levels for describing the video. The sync area of the composite signal is not wasted entirely, because it can be used to embed additional data including multiple audio channels. ■

Acknowledgment: This article was prepared with materials supplied by Michel Proulx, Leitch Incorporated and Synergistic Technologies, Incorporated. Additional information was taken from "Your Essential Guide to Digital" by John Watkinson.



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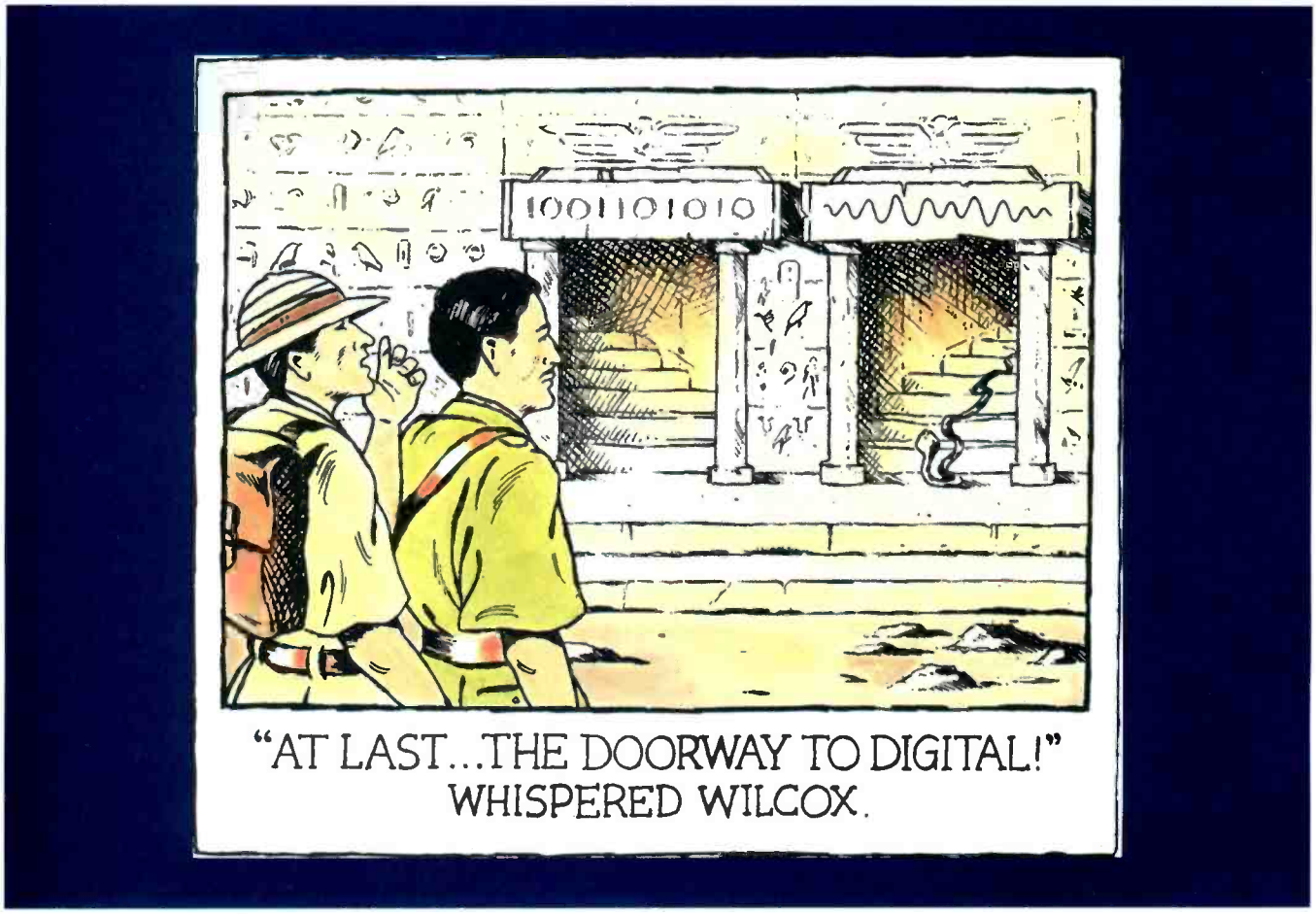

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By Richard Farquhar

The mark of excellence

The Society of Broadcast Engineers (SBE) introduced the Certification Program in 1975. Since then, engineers have been asking "What is in it for me?" or "Will certification help me gain employment or keep my job?"

While gathering information for this article, I was looking for people who could give testimonials or relate real-life stories of how being SBE certified enabled them to find the job of a lifetime. I am sure there are many such stories out there, and if I researched long enough, I'm sure I could share an impressive list with you. But it is more important for you as the engineering professional to create your own testimonial. You can be part of America's new future by helping to create it. Professional organizations such as SBE, SMPTE, IEEE or ITVA can provide the tools you need to begin creating your own testimonial.

Professional organizations can provide the tools you need to begin creating your own testimonial.

Create your own testimonial

What can you do to create your own testimonial? You read a book from the beginning to the end. In creating your testimonial, you work backward. You start with the ending you want and then you do everything you must to reach the beginning of your book.

The first thing you need to do is rid yourself of the current American work ethic of doing the minimum level of service necessary to satisfy your employer. Second, stop being a backseat driver and let the boss know you stand behind him. Many engineers are content to sit in the back room, repair a black box and talk about what is wrong with the other departments in the company. They are reluctant to come out and work with the other departments for the mutual good of the company. You cannot sit around and complain about other departments or the way they do business without damaging your own reputation. Remember, "the scent of the rose lingers on the hand that threw it."

Making the effort

As a manager, I am always pleased when someone makes an effort to help me do my job. Managers do not have all of the answers (even if at times they think they do). They need your input. What would happen if you stopped complaining and started taking an active interest in resolving situations that affect other departments within your organization? What would happen if you made the effort to communicate with those other departments and actually pitched in and made suggestions?

If you are not being invited to daily, weekly or monthly staff or department meetings, why not simply say "I want to learn more about our operations so may I attend your meetings?" At a facility I worked at a few years ago, two new managers came onboard and did exactly that. The results were fantastic. New ideas were shared and we created a team that became unbeatable. Everyone viewed everyone else as a professional.

If you follow the advice of author and teacher Dr. Edward Deming, you will have something better than a testimonial; you will have the respect of your peers. Here are Deming's four steps to success:

1. *Be a leader:* Successful people are leaders. They inspire others to do their best and bring about greater results all around them. Subordinates do a better job of solving problems and coming up with creative ideas. Leaders make good and timely decisions and are self motivated.

In other words, stop talking about the situations in your facility and become involved in correcting them. Each day resolve to enrich the lives of three people. It doesn't take much effort. If your receptionist has a good phone voice, tell her so.

2. *Be organized:* Most successful people manage their time well. They make time work to their advantage rather than against it. They are organized and remember what needs to be done. Their days are planned, and everyone seems to be amazed at how they can accomplish so much and how many different types of projects they can handle. Throughout the day ask yourself, "Is this the most valuable use of my time?"

3. *Be a time manager:* People who properly manage their time find themselves able to get more things done without running out of time. The quality of their performance increases, and they can accomplish more in fewer hours. They rarely miss deadlines.

Plan each day's activities the night before. If you don't have a plan, you will end up somewhere. Choose your direction.

4. *Be a good communicator:* Most successful people are good communicators. In many cases, people who make it to the top are not those with the best technical capabilities, but those who are best able to communicate. To improve your ability to communicate, concentrate on the following:

- Develop good speech
- Speak at a moderate rate of speed
- Use words your listeners understand
- Be a good listener
- Develop your public speaking
- Understand and use body language
- Speak with a purpose
- Know how to get and keep attention
- Speak clearly and concisely

As you work at Deming's four steps to success, you will be more successful and be more in control of your own destiny. You will have your own testimonial in the form of letters of recommendation from your employers, raises and more. As Zig Ziglar once said, "America was built by people pulling on the oars, not resting on them." You need to pull your own boat away from the dock and move to the open sea. You will be glad you did.

Continuing education

Engineering is a dynamic field and those who decide to enter it must commit themselves to a lifetime of education. For engineers, receiving a college degree or SBE certification is just the beginning of the learning process. Whether you are an accountant, engineer or association executive, your professional organization has tests to measure your professional growth. No one can guarantee you lifetime employment, but by following the steps outlined here and becoming professionally certified, you can achieve a professional level that makes you proud. Work always comes to those who are prepared. Are you ready? ■

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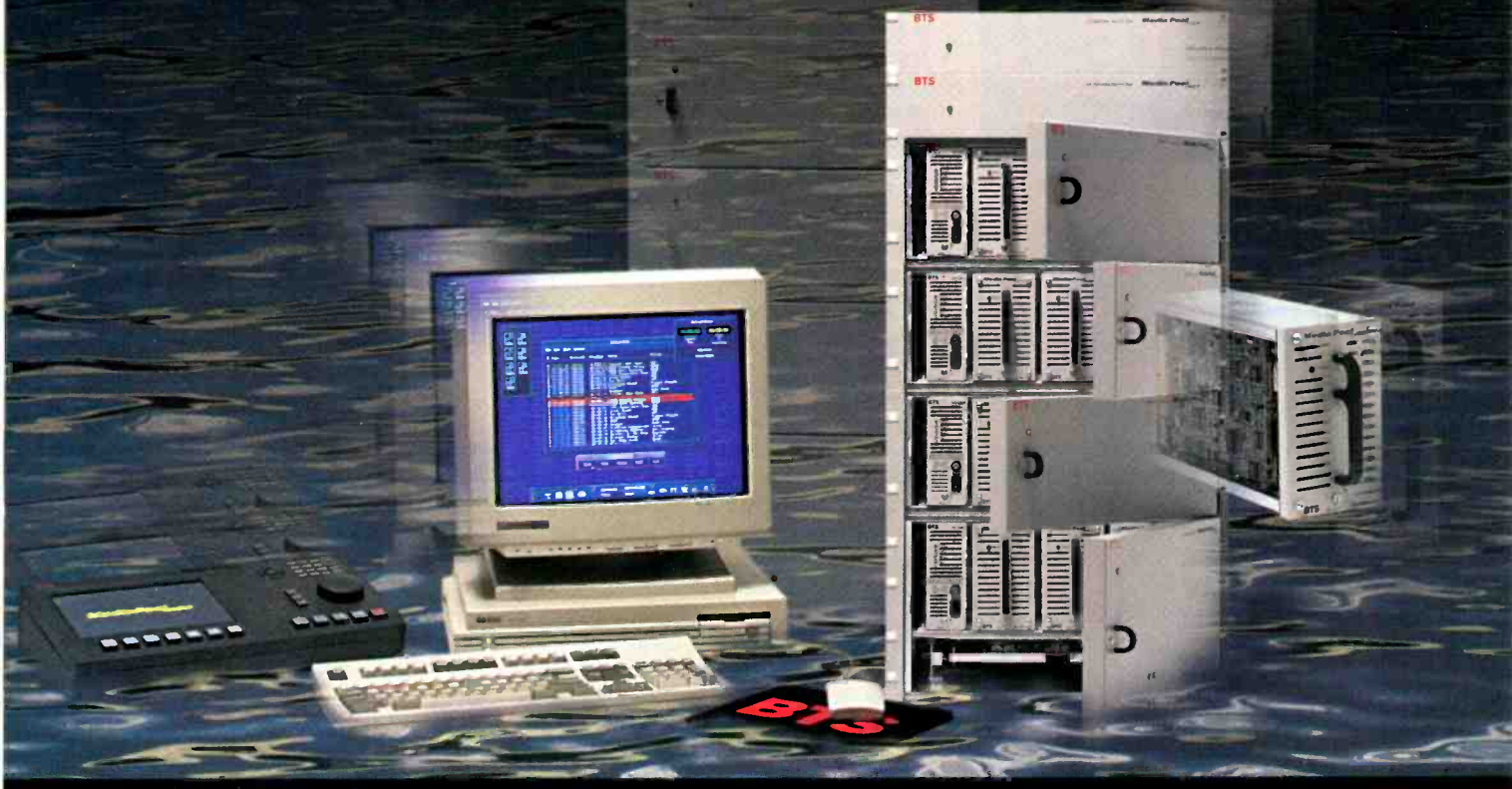

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By Chris Leonard

Managing resources in a computerized environment

Managing resources is an umbrella business term referring to the monitoring, decisions and action taken in regard to virtually every element of your business to enhance profitability. Valuable tools in accomplishing this goal are automation and integrated facility management software. Most businesses are computerized to some degree, but a fully integrated system allows more complete and specific resource management data to be compiled and analyzed.

In the broadest sense, resources fit into two categories: people (talent, operations, support, management) and things (suites, equipment, cash, tape stock, trucks, etc.). Facility management breaks down these resources into three applications: monitoring projects, inventory management and profitability management.

Monitoring projects

The primary benefit of monitoring projects using integrated facility management software is instant access and updating of real information. When based on factual input, intelligent decisions can be made by production personnel and clients on a more timely basis. Job changes are instantly posted to schedules and/or work orders, cost changes are automatically implemented and anyone with security clearance can pull up the new parameters from on-site or remote locations. By tracking every element along the way, clients and producers can prevent problems or omissions, track actual costs vs. budgets, estimate costs for job completion and avoid last-minute crises and confusion.

Another resource management tool is precise billing of elements. The practice of bundling costs (lighting, grip equipment, catering, transportation or other peripheral services) can be costly and agitating. By employing an integrated management system, individual items can be automatically priced at the bidding stage so there is less money that falls through the cracks, and clients aren't upset at being charged for items that they didn't use or need.

Integrated scheduling software is fundamental in monitoring resources. Information from the bidding process can be pulled up, special client rates can be accessed and applied, and any applicable purchase orders can be generated and posted to the work order. Past client preferences, present schedules and future schedules can be viewed with a few keystrokes. Room configuration templates can be applied, changed and approved at this time. Bookings can be made with various levels of *hold*, *firm* and *bought*. Potential resource conflicts are flagged and the availability of any given resource at any time can be noted at a glance. Therefore, conflicts can be avoided or resolved ahead of booked time, and client confirmations can be electronically sent immediately or at a specified time.

Let's say you are managing a production from several remote sites with many variable conditions. All of your transportation, equipment, tape, talent and engineers are scheduled, confirmed, priced and approved prior to the shoot. If, after the teams are on site, any last-minute equipment or personnel transfers, rentals, image retrievals, scheduling adjustments or other job changes crop up, any remote site can instantly hook into the software system via modem, find the best and easiest path to procuring or changing the needed resource, and communicate the changes to other remotes, pertinent office staff or to the client, all in a matter of minutes.

Inventory management

For this article, inventory refers to tape and/or film stock. This can be categorized into news footage, raw stock and client stock. In newsroom systems, many parameters can be applied to retrieve materials, including *air date* and *time*, *story*, *subject*, *key word* and *reporter*, to name a few.

A computerized tape vault system that is integrated into your overall facility management system provides an excellent means of tracking inventory and costs more accurately. Physical inventories can be handled through bar codes and bar code readers. Complete or specific raw stock can be instantly viewed and noted by number in stock, number on order and number on back order. Individual raw stock items can be automatically flagged when they fall below specified reorder amounts. Inventory discrepancy reports can be generated at any time for evaluating shortages and non-billable usages. With integration, your vault program can be automatically updated from any applicable purchase orders and the program can automatically post tape usage, shipments and costs to the client work order.

Client libraries can be set up and searches conducted by preset or custom parameters. Clients also can access their libraries from their offices using a modem and security codes. Client pricing, ship to addresses and labeling instructions can be electronically noted and accessed and movement is posted directly to work orders. This information can be reported in many ways to better evaluate use and minimize losses.

Profitability management

Resource profitability and management is derived from the reporting capabilities of your system and management's ability to make decisions based on these reports. The variety of reports should be evaluated singularly and in combination with others in a timely manner. By doing so, problem areas and revenue losses can be pinpointed and corrected before they have a major impact on the P&L statement.

Resource utilization reports along with sales reports are extremely useful. A summary of resources scheduled by hours booked, pricing or client would make a good start for your analysis. Combine that information with sales reports by department, room, line-item equipment, tape stock, account executive, producer, client or client type.

You now have more powerful tools to help make sound decisions and judgments. This information provides a base for evaluating profitability and productivity of your sales and operational staff, equipment, rooms, departments, clients and client types. From this data, you can direct training and pay raises, ascertain what departments or equipment you should enhance or promote and help determine which clients to pursue.

By perusing maintenance reports, equipment downtime reports, non-billable item summaries and similar reports, you can evaluate and control many of your costs. Staff productivity vs. billing analyses and employee billables/billable overtime/administration time summaries are effective in determining patterns and changes in employee productivity and profitability. Purchasing and rental reports by item and vendor are helpful in ensuring that you are receiving the best prices and can pinpoint equipment that would be more profitable if supplied internally rather than through rental services or vendors.

Job productivity rises because people can spend more time generating income and less time on non-billable functions. By raising the productivity of your resources and evaluating their use, the flow of dollars to the bottom line can only increase. ■

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By Greg Monti

Receiving E-mail

Last month we took a look at sending E-mail and the way it can give your station and its staff quick worldwide connectivity for short text messages. Receiving E-mail is a different story because when someone else is doing the sending, you'll think they control your life.

Your E-mail address

The first thing you'll want to do once your station has E-mail service is to publish an E-mail address at which you want to receive correspondence. There is no complete directory for E-mail addresses, although at least one publisher has gathered E-mail addresses from Internet news groups in an attempt to create such a directory.

You'll have to publish your E-mail address, such as in print advertising, on your letterhead, on invoices and checks, during credits or promos for news or other shows, on other people's computer bulletin boards and on Internet news groups. If your station has a World Wide Web home page, publish your address there. (A home page is an electronic brochure or advertisement about your station that is available to a relatively small but growing percentage of Internet users.) A handful of broadcasters, such as NBC Television and National Public Radio, have published E-mail addresses for some or all of their news programs.

Looking in the box

Once your address is public, you'll start receiving E-mail in your "In Box." It may take several days for you to get your first message or you could receive one in the first five minutes. And it could be on just about any subject: a listener with a question, a viewer complaining about your anchorman's politics or his hair style, a laser-printer toner salesman looking for leads or a potential advertiser inquiring about your station's audience.

If you want to show the world that you are serious about accepting E-mail, you will have to answer each one that is of any significance. Also, you'll have to budget staff time for answering E-mail. With a bit of proper training, a public relations staffer could handle answering your E-mail along with other duties. With time, you may find that the number of E-mail messages the staff must answer per day will dwarf the number of paper letters that are delivered to your front door. Paper letters take more time to prepare, print and mail, so viewers or listeners with computers and access to E-mail will generally take the E-mail route to correspond with you.

Anyone with the right level of E-mail access and some enthusiastic student know-how could read credit card numbers and use them for less-than-legal purposes.

E-mail triage

To avoid the personnel and office space costs of another staffer, you'll have to divide up the incoming E-mail. Sort the mail into those messages that require an immediate, businesslike answer, those that are pro and con on some issue of the day (which may only need to be tallied), those that are so off-the-wall that you can't figure out how to answer them and junk E-mail. Ask yourself these rhetorical questions and set down procedures:

- Do we answer every E-mail from an audience member or do we have our information systems department set up an "auto reply," an E-mail form letter thanking the viewer or listener for his or her opinion without giving a personalized answer?
- How do we handle E-mail advertisements from potential vendors? Erase it without reading much of it? Send a form letter reply that you are not interested in those products or services? Save the sender's message (or at least their E-mail address) in case you want to do business with them later?

In any case, you'll want to assure yourself that your station's staff can respond in a timely manner to E-mail messages that deal with subjects you would consider important if they arrived by U.S. mail, by phone or by fax. By publishing multiple E-mail addresses, you can get the senders to do some of the sorting for you. For example, some multiple addresses might include:

programming@wzzz.com
sales@wzzz.com
engineering@wzzz.com
news-tip@wzzz.com
lunchtime-request@98fm.wzzz.com

May we serve you?

To get people onto an E-mailing list, you'll have to set up a computer to act as what's called a *list server* or *listserv* for short. A listserv is an application running on a computer at your station that accepts E-mail addresses from outsiders and adds them to a mailing list. Your publicity or promotions people can compose a list of weekly programming highlights or a monthly program guide that is automatically sent by E-mail to everyone on the list at that moment. (KASU-FM at State University, AR, is doing this now.) Members of the public can add themselves to — or remove themselves from — the list at will. Be sure that what you send out is compelling enough to keep that audience interested. Setting up a listserv requires a computing professional with Unix system experience.

Selling via E-mail

In your electronic newsletter, you could advertise products or services, such as transcripts of news reports and talk shows, licensed sports merchandise or advertiser products. Although it is possible for E-mail users to send you their credit card numbers, expiration dates and billing addresses, there is a significant drawback: security. Individual data packets and E-mail messages on the Internet travel as plain text. Leased data circuits, which make up most of the Internet, pass through routing computers that could be on anybody's premises, including that of a university computer lab. Anyone with the right level of access and some enthusiastic student know-how could read those credit card numbers and use them for less-than-legal purposes. Some E-mail users know this and others don't. Stay out of legal and public relations trouble by warning users that credit card transactions are not secure. Private firms and standards agencies are working on ways to allow retail commerce on the Internet, but the issue is not settled.

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From the brightest lights to the darkest jungles, the KY-27C's automatic level control and full-time auto white provide continuous shooting. Plus, a Triaxial System permits operation up to 5,000 feet, empowering it with incredible field worthiness.

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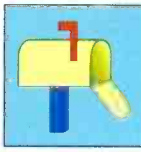
But it can also include out-of-town participants who may not be able to view or listen to your station over the air. America is full of Nevadans who used to hail from New Hampshire or Floridians who grew up in Illinois. They may be interested in your station. Your sales department probably won't be able to charge advertisers a premium rate to have their products and services plugged on your station's E-mail listserv. Not yet, anyway. But, if E-mail becomes a viable marketing tool three years from now, wouldn't you like to have an E-mail marketing database already in place?

Advertising culture wars

Don't send unsolicited advertising to your E-mail list. It will be promptly noticed and your station's other E-mail addresses will be promptly "flamed" with complaints. The Internet started out non-commercial, and many believe it should remain non-commercial. The Internet mindset is often stereotyped: "Leave me alone. Don't censor me. Don't advertise to me. Don't tax me. Don't sell to me (unless I'm really interested). Don't charge me. Give me information for free." By having a public relations staffer keep up with changes in the Internet culture, you can use E-mail to build relationships that improve your station's chances of successfully branching out into alternative media. ■



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Greg Monti is technical manager of National Public Radios Future Interconnection System Project Office. He may be reached by E-mail at gmonti@cais.com.

Internet road map

INFOSEARCH is an Internet resource that maintains a comprehensive hypertext directory of broadcasting-related sites on the World Wide Web. As a service to the industry, any bona fide broadcast-related company that has a World Wide Web site can get linked to the INFOSEARCH free of charge. There is an on-line sign-up form directly from the INFOSEARCH broadcasting links site. The URL for the INFOSEARCH site is: http://www.xmission.com/~insearch.

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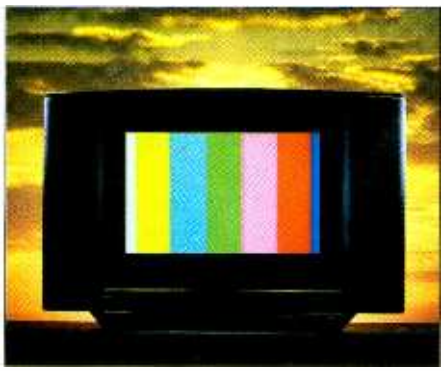
By Louis Libin

ATV channel assignments



In each area of the country, the new ATV channels will be found among those TV channels that are not used for NTSC broadcasting in that area. The broadcast channels for NTSC were allotted to cities across the country by a complex set of rules based upon providing for minimum separation distances between the use of certain pairs of channels. The intent was to minimize the potential for the broadcasts of a distant station to interfere with the reception of a local station.

The possible channels for ATV in each area are to be found among the NTSC allotments that were never constructed and among the channels whose use for NTSC would cause objectionable interference to existing NTSC stations. The FCC has also announced the intention to allocate *only* UHF channels for ATV. This may not be entirely possible, but certainly most of the new ATV assignments will be in the UHF band. There may be some VHF ATV assignments where UHF assignments are not possible, such as areas where available UHF channels for ATV are scarce. The geographic distribution of NTSC channels and the potential for interference between stations make it difficult to devise a nationwide set of ATV channel assignments that avoid inequities among the channels assigned. *The channel assignments must be carefully crafted for the major markets and for the nation as a whole.* Available channels having the larger co-channel separation distances are preferred. A table of ATV channel assignments recommended by broadcasters has been recommended to the FCC and is available for review and comment.

Chief engineers should be prepared to evaluate the service area of their new ATV channel assignments and should begin preparing to build ATV stations. The FCC Office of Engineering Technology has long used computer software to assign broadcast channels satisfying the technical and regulatory constraints for a particular service. ACATS technical committees have developed receiver planning factors and a model for predicting ATV coverage and interference. Broadcasters have supported this work by providing computer resources and funding software development. They have also built upon and enhanced the assignment model used by the FCC. (See "Spectrum Studies for Advanced Television Service in the U.S." by William Meintel, 1994 NAB Broadcast Engineering Conference Proceedings.) The ATV service and interference characteristics of the assignment plan developed with the aid of these programs depend on parameters, assumptions and guidelines that must be determined prior to running the model.

In the general approach to making the ATV channel assignments, an allotment table is formed by considering each city or area in turn across the country. For each area, one prepares a list of channels that are candidates for ATV assignment. First, channels that are used in this or nearby cities are eliminated because their use for ATV would cause unacceptable interference to the reception of an existing NTSC station. Other channels are eliminated because they would be susceptible to interference from NTSC stations or ATV-to-ATV interference would result. The channels allotted to one city restrict the channels that can be allotted in nearby cities, and in turn, this effect spreads like a daisy-chain across the United States. When a list has been prepared for each area, the service areas of the ATV channels are calculated and matched to the existing NTSC service areas. Adjustments are then made to better satisfy certain optimizing criteria.

Channel assignment program

This program is used to assign an ATV channel number to every NTSC station in the United States. The assignments are made so that minimum geographical separation distances are maintained between the use of certain pairs of ATV and NTSC assignments. The most important constraints are the distances between two uses of the same number channel for two ATV stations or for an ATV and an NTSC station; this is the co-channel constraint. Also important are the separations between channel numbers that differ by one – – the adjacent-channel constraints. There are additional constraints at the Canadian and Mexican borders and between certain offsets of UHF channels termed the UHF taboos.

The program begins with a list of all the NTSC stations. For each station, the program calculates the distance to the nearest use of each TV channel. The channel with the greatest separation distance is examined first. If this channel satisfies all the separation constraints, then a tentative ATV assignment is made. If not, then the channel with the next greatest separation is tested. If no channel satisfies all of the constraints, then no ATV assignment is made. This process is repeated for each NTSC station. There are many assignment tables that could be considered and many have entries consisting of a pair of stations that violate one or more of the separation constraints. Also, the resulting ATV service areas vary from table to table. As an indication of the complexity of this process, the number of possible nationwide assignment tables is greater than 10 followed by more than 3,200 zeroes.

Coverage and interference model

The channels of an assignment plan are evaluated by using the coverage and interference model. The ATV channel power is set so that the ATV signal can be received at the maximum radial of the paired NTSC channel's Grade B contour. Then the ATV coverage is calculated, taking into account the transmitting antenna pattern of the NTSC station and signal propagation over the terrain. Finally, the impact of other ATV and NTSC stations is considered to determine the loss of service area due to receiving interference from those stations. For most of the ATV channels, there will be no problem satisfying the goals. A number of stations in spectrum-congested metropolitan areas may not have completely satisfactory service areas.

Some areas have so many TV stations in close proximity that it is difficult to fit in an equal number of ATV channels. As geographic problem areas are identified, the assignment program can be run separately for each area. The number of stations in one local area is small enough to completely optimize assignments in a reasonable time. Thus, many local plans can be evaluated to optimize the service areas within that area. These local plans can be "seeded" into the list of NTSC stations for running the assignment program for the entire country. The resulting assignments are then evaluated using the coverage and interference model program to calculate service areas. This may lead to adjustments in local assignments and a new national assignment table. This complex procedure has been repeated until the improvement in service areas become negligible. The result is a table of NTSC–ATV channel pairings with the assigned ATV power, the areas and populations of the NTSC and ATV coverage and the areas and populations lost to interference from NTSC and ATV stations. ■

Louis Libin is director of technology for the National Broadcasting Company (NBC), New York, NY.

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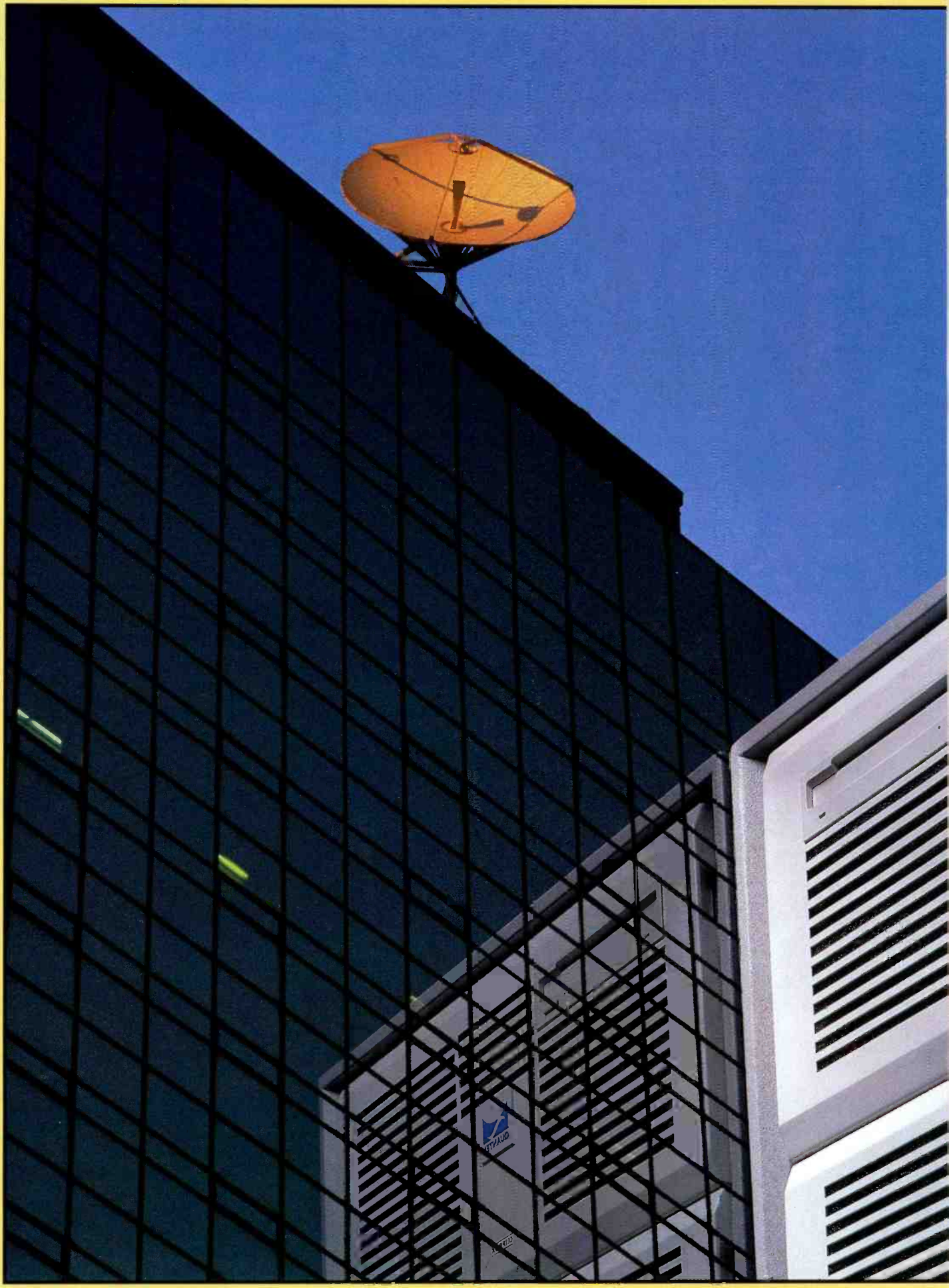


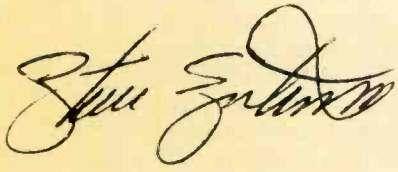
The changing dynamics of storage technology

As computers become more powerful, they are replacing many traditional "black boxes." Today, video is handled almost entirely by microprocessor-based systems, many of which are integral to dedicated boxes.

Despite the advantages offered by the new and powerful devices, the computer manufacturers are only beginning to recognize the extreme complexity of handling "real-time" video without artifacts and delays.

With this in mind, this issue looks at video storage technology. We are all familiar with the advantages and disadvantages of tape storage, so it is only touched on here. Disk drive technology, both magnetic hard drives and opticals, are examined in depth, as is RAID technology. Engineers and managers can use this information to analyze current and future needs and find cost-effective solutions to their storage needs.

Tape, disk and optical storage systems all have their strengths. Maximizing those strengths is the key to making the most of this technology.



Steve Epstein, issue editor

Combining tape and disk storage

By Tim Slate and Ray Baldock

How well do tape and disk systems play together?

The Bottom Line:

Professional hard-disk recorders used to store compressed video offer flexibility, convenience and cost savings in handling commercial spots, interstitials and short program segments. However, for many broadcast applications, tape may remain the medium of choice for longer-format program material for the foreseeable future. $

Advances in data compression are bringing hard-disk storage technology out of its traditional home in the computer industry and squarely into the midst of the broadcast and post-production industries. Disk storage is a high-volume technology that's reliable, economical and proven. Coupled with a well-designed professional disk recorder, hard-disk technology promises unsurpassed flexibility for storage, editing and manipulation of digital video.

But what does the advent of disks mean for the hundreds of thousands of dollars invested in videotape recorders? What are the advantages of disk storage, and when is tape preferable? What do you need to know so you can take full advantage of disk storage technology? This article looks at combined tape and disk storage systems and the advantages they offer.

Multichannel recording

Hard-disk storage represents a milestone in the transformation of television from analog to digital. A typical hard-disk storage system consists of a disk array and a controller unit. Under software control, the system records, files and plays back video and (usually) audio material, moving it to and from the disks as needed. A variety of other capabilities may also be included. Some systems provide multiple internal digital disk recorders (DDRs) with the ability to record or play back multiple audio and/or video channels independently and simultaneously. Source signals can come from a VTR, a VTR playout system or a satellite receiver. External signals can be integrated with video played back from the internal recorders using either internal or external switchers. Paint and effects software may also be included for video manipulation.

Given such broad capabilities, hard-disk storage systems can meet diverse needs, often in ways that extend or complement existing tape-based systems. One role for disk recorders is serving as a cache for a VTR or automated tape library system. Caching takes its name from the computer world, where frequently used programs and data are kept in fast memory devices for quick access by the CPU. Disk caching relies on one of the key differences between disk and tape; information stored on disks can be randomly accessed.

Combining random or non-linear access with multiple record and playback channels makes disk caching a powerful capability for playout of long- and short-form material. For example, the ability to provide multiple, staggered start and stop times makes it possible to play out a movie to many users from a single stored copy. This is ideal for video-on-demand and near-video-on-demand applications. In many cases, however, the cost of storing many hours of long-form material can be prohibitively expensive. Disk caching short-form material is far more cost-effective.

One TV network that benefits from disk caching's short cycle time is La Cinquieme. It is a publicly funded, privately run UHF network that provides educational programming throughout France. Much of La Cinquieme's programming consists of short shows, many just 15 minutes long. Disk caching is used to store and play out hundreds of promotional spots and short program segments each day. According to the station's technical manager, Sylvain Anichini, "Without the disk recorder, it would be hard to broadcast so many short events, since the back-to-back time cannot be supported by the traditional spot replay methods." Without it, some longer-duration material would have to be inserted.

Support for multiple stations

A multichannel professional disk recorder can also provide affordable disk caching for multiple channels simultaneously — a capability that's being put to good use by the TV3 Broadcast Group in London. Along with its TV3 commercial broadcast, the group offers the TV1000 and TV1000-Cinema subscription movie channels. Customers

Continued on page 32

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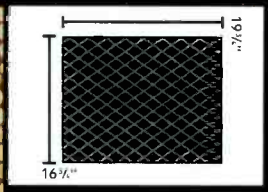

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IT WAS JUST ANOTHER PEACEFUL DAY IN THE LIFE OF BERT CANAVAN, SALES MANAGER. THEN, THE PHONE RANG...

Continued from page 28

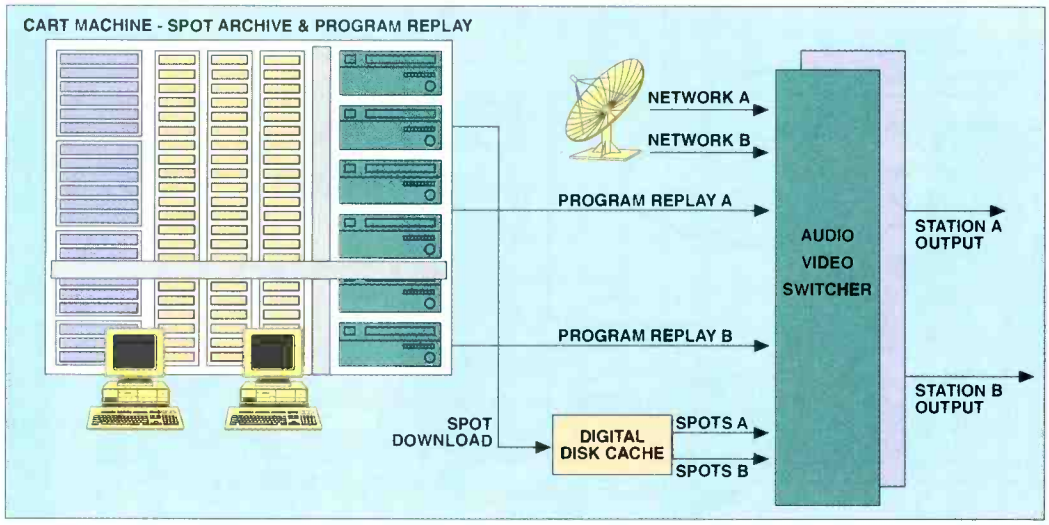

Figure 1. Serving as a disk cache for commercial spots, a professional disk recorder can provide spot playout for multiple channels from the same set of disks.

who subscribe to TV1000 receive TV1000-Cinema for free; both channels play the same movies but on a different schedule. Having the second channel increases value but not revenue, so an affordable way of providing this service is needed. The disk recorder plays back promotional materials and interstitials for both channels, as well as short segment material to fill out the hour segments.

GloboSat, the cable arm of Brazil's TV Globo and one of Brazil's largest subscription channel providers, also puts multichannel disk recording to good use. One disk recorder handles promos and commercials for GloboSat's own movie, sports, entertainment and news channels. Another disk recorder stores and plays back commercials for GloboSat's rebroadcasts of the Fox and CNN networks.

Time delay flexibility

Multichannel disk recorders can record video and audio and play it back, delayed, while continuing to record, freeing tape machines for other uses. This feature makes them ideal for program delay, whether the goal is a 10-second delay or to capture programming for playback in a later time zone. When ongoing delays are needed that are longer than the duration of a tape (a 4-hour time delay with 3-hour tapes, for instance), disk technology's higher storage capacity is particularly cost-effective, because it avoids the need for an additional tape deck.

CBS currently runs 10 D-2 tape machines non-stop for each time zone delay; five machines record the network signals, and the other five provide redundancy. The network is currently initiating a system that replaces all 10 tape machines with two disk

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recorders. "Doing time zone delays for several different time zones can tie up a quarter of a million dollars in tape machines very quickly," explained Robert Seidel, vice president of CBS Engineering. A 4-channel disk recorder "essentially provides four virtual VTRs. In terms of the sheer number of tape machines involved, we expect to realize a significant savings in capital and free those assets for other uses."

Peaceful coexistence

As the previous examples suggest, disk and videotape are best viewed as complementary, rather than competing technologies. At roughly a nickel per megabyte, tape is far less expensive than disk, and currently is the storage medium of choice for archival purposes and full-length programming. For short elements, on the other hand, disk technology can increase reliability, performance and system storage capacity, while reducing overall cost.

Disk storage can extend the lifetime and the utility of existing tape equipment. Disk caching can enable one robotics system to serve as a central archive for spot insertion on multiple independent channels. Spots stored on archive tapes in the library can be downloaded to the disk recorder cache on an as-needed basis, enabling a single 4-channel disk recorder to support as many as three on-air channels simultaneously. Caching can also lessen the wear and tear on tapes, tape heads and robotic systems because tapes are used only to load the disk cache, not for play-to-air. Each element is loaded only once, regardless of how many times it is repeated during the broadcast day. The VTRs that are freed up can be used for archival storage and the playout of long-format material. This can significantly increase the amount of material on-line without adding expense.

In addition, disk-based systems should bring about a reduction in maintenance costs and an increase in reliability. The mean time between failure (MTBF) for disks is close to 800,000 hours and rising. (See the related article, "RAID Storage Technology," p. 40.) A small array of eight drives yields an array MTBF of close to 10 years! Operating costs are lower as well because there are no heads to clog and no brushes or rollers to clean and replace.

Compression quality

Although hard-disk technology has a proven record in the computer industry, a successful disk storage system for TV applications must be tailored to the requirements of professional TV production and playout. When evaluating disk storage systems, look for the features you will need and use, and pay attention to image quality.

TV disk storage systems rely on image compression to compensate for the tremendous amounts of data needed to represent a video image. For example, a single second of uncompressed CCIR 601 video contains more than 21MB of data, and an uncompressed 30-second spot nearly fills two 340MB hard disks. Not only must the system store this data, but to deliver several streams of video to multiple output channels, it must carefully manage the data flow to ensure a continuous video stream to each channel. Without compression, this task can quickly overwhelm even powerful microprocessors, fast buses and high-speed system-to-disk interfaces.

Compression has been applied throughout the history of the TV industry to deliver practical solutions economically. Representing a continuous image as 525 or 625 lines is a form of compression, as is the sampling of a moving image at 25 or 30 frames per second or the interleaving of luminance and chrominance signals. Modern digital compression techniques extend these principles by eliminating redundancy in the picture.

For professional TV applications, digital disk recording systems succeed or fail on the quality of their compression. Successful systems must compress image data enough to manage it in real time and ensure that when

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played back it meets quality expectations. Steady progress in algorithms and compression hardware have improved image quality to a level that is acceptable to the TV industry.

Regardless of the compression standard used, the results will depend on the manufacturer's sophistication and expertise in implementing the standard. In addition, image quality is affected by interaction between compression schemes and noise in the signal being compressed. For example, interference artifacts between the chrominance and luminance information can impair the picture. These artifacts are represented as image data and bandwidth is wasted compressing them and then playing them back. Thus, the better job a system can do on decoding incoming signals and reducing noise without reducing detail, the better job of compression it can do and the better performance it will provide.

Objective test methods for compressed video systems are being developed. For now, however, the proof of image quality must be in the playback. Careful comparison of the compressed/decompressed video with the original uncompressed video will help when making a subjective judgment of the results.

Performance and flexibility

In addition to high image quality, disk storage systems must provide high performance and flexibility for TV applications. Disk storage systems may provide an industry-standard bus, such as EISA, to control internal devices, such as the disk recorder boards, I/O modules, and mix/effects, and to handle audio data. Even with data compression, however, traditional computer buses are not up to the job of transferring high-quality video data in real time. Systems that rely on a bus architecture severely limit the number and the quality of simultaneous video and audio streams. If you're evaluating disk storage systems, expect to find sophisticated routers or other custom hardware that supplement the standard PC bus in moving the data internally.

Along with the system's central processor, look for dedicated real-time controllers for tasks such as field-accurate playback and switching of video and audio signals. Above all, look for a system that has been designed by people who understand television, not by computer specialists trying to move into a new market. This can become apparent when attempting to integrate the system into the real world. EMI/RFI problems are common in station environments and can wreak havoc on systems if they are not properly designed.

Choose a system with an architecture that interfaces readily with your existing production equipment. Because professional disk recording is still a new and expanding field, look for a system designed for future growth and the addition of new capabilities — from new compression codecs to new video standards and interfaces. Make sure the system also provides a range of recording and playback options, plus the features you need for frame-accurate editing.

In short, computer-based hard disks have long been a cost-effective, reliable storage medium. The combination of high-capacity disk storage and advanced compression techniques have allowed professional disk recorders to provide flexibility and power in handling short elements. These systems can also extend the life of existing tape equipment and robotic library systems, and give them new power as well. ■

Tim Slate and Ray Baldock are product marketing managers in the Video and Networking Division at Tektronix, Beaverton, OR.

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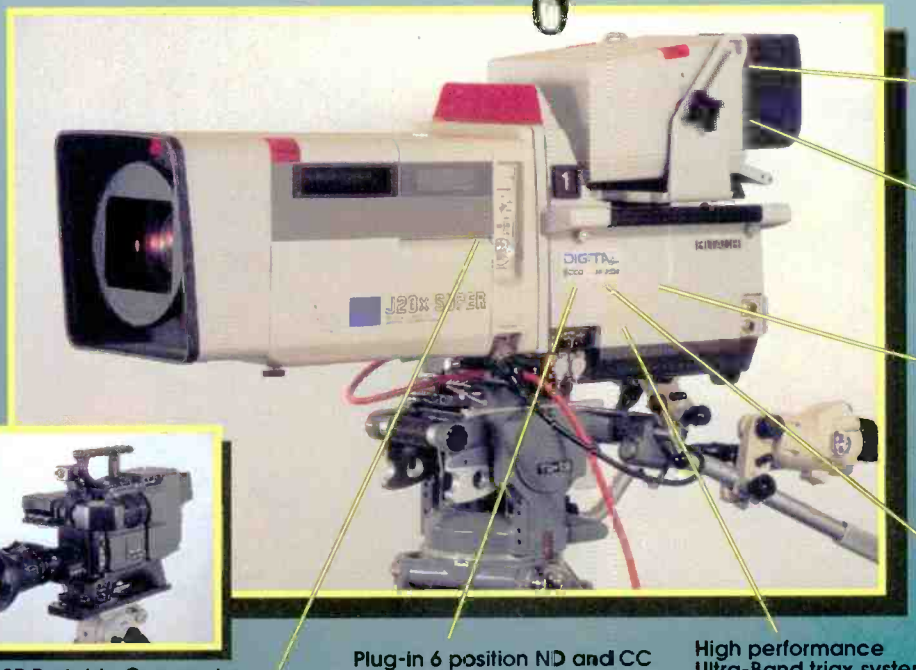

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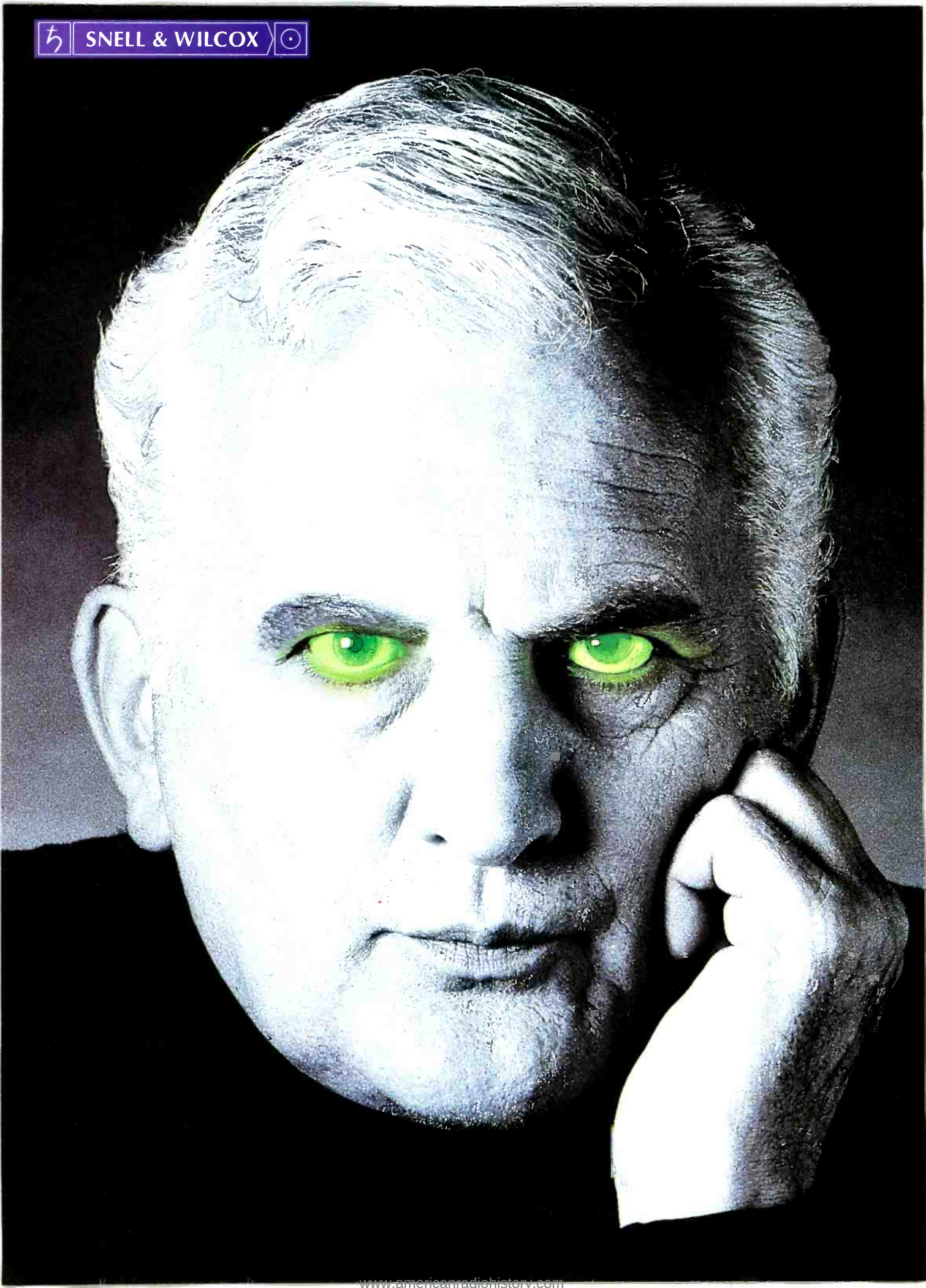


RAID storage technology

By Bill Moren

RAID arrays are needed even with 100-year MTBF disks.

The Bottom Line:

Disk drives, like airliners, don't crash often. But when they do, the amount of damage can be tremendous. Fortunately, a technology called RAID acts as your disk drive's seat belt — keeping the data intact and available after a drive crashes. Even though some disks have published MTBFs of one million hours, using them without RAID in real-time broadcast applications can be like flying without your seat belt fastened. $

How would you feel if the airline you fly with removed all the seat belts, took out the escape slides, sealed the emergency exits, and eliminated the fire extinguishers because, on the average, they crash only once every 400,000 hours of flight? Feel like taking the train?

Disk-drive Mean Time Between Failure (MTBF) is a much-talked-about and generally misunderstood term. The methodologies used by manufacturers to establish MTBF specifications have changed over the past several years. The newer methodologies aren't necessarily better or worse than their predecessors — they're just different, reflecting a different view of how to express the reliability of a family of disk drives. This change, and general improvements in disk-drive technology, are the catalysts for an increase in published MTBFs from under 50,000 hours to well over 500,000 hours and in some cases, more than 1,000,000 hours (114+ years!). And they continue to increase.

MTBF

The MTBF calculation is a statistical method for predicting the reliability of a device. For electronic components, there are published standards for calculating MTBFs. The MTBF of a device is generally determined by the failure rates of the device's individual components. Failure rates for individual components are standardized and found in published reliability references. The arithmetic average, or mean, of the component failure rates yields the device's failure rate, which is easily expressed in hours between failures.

This type of MTBF calculation is interpreted as a prediction of a device's life. In fact, it was common for a drive's warranty and MTBF period to be approximately the same. This methodology predicts the useful life (a component failure rendering a device useless) of an individual device. But it is only a prediction, and then, it only predicts the average time between failures. If you installed a number of like drives, some would fail before reaching the MTBF while others would last well past the MTBF. Furthermore, it often assumes a period of infant mortality with a decreasing rate of failure until the device's steady-state failure rate is reached.

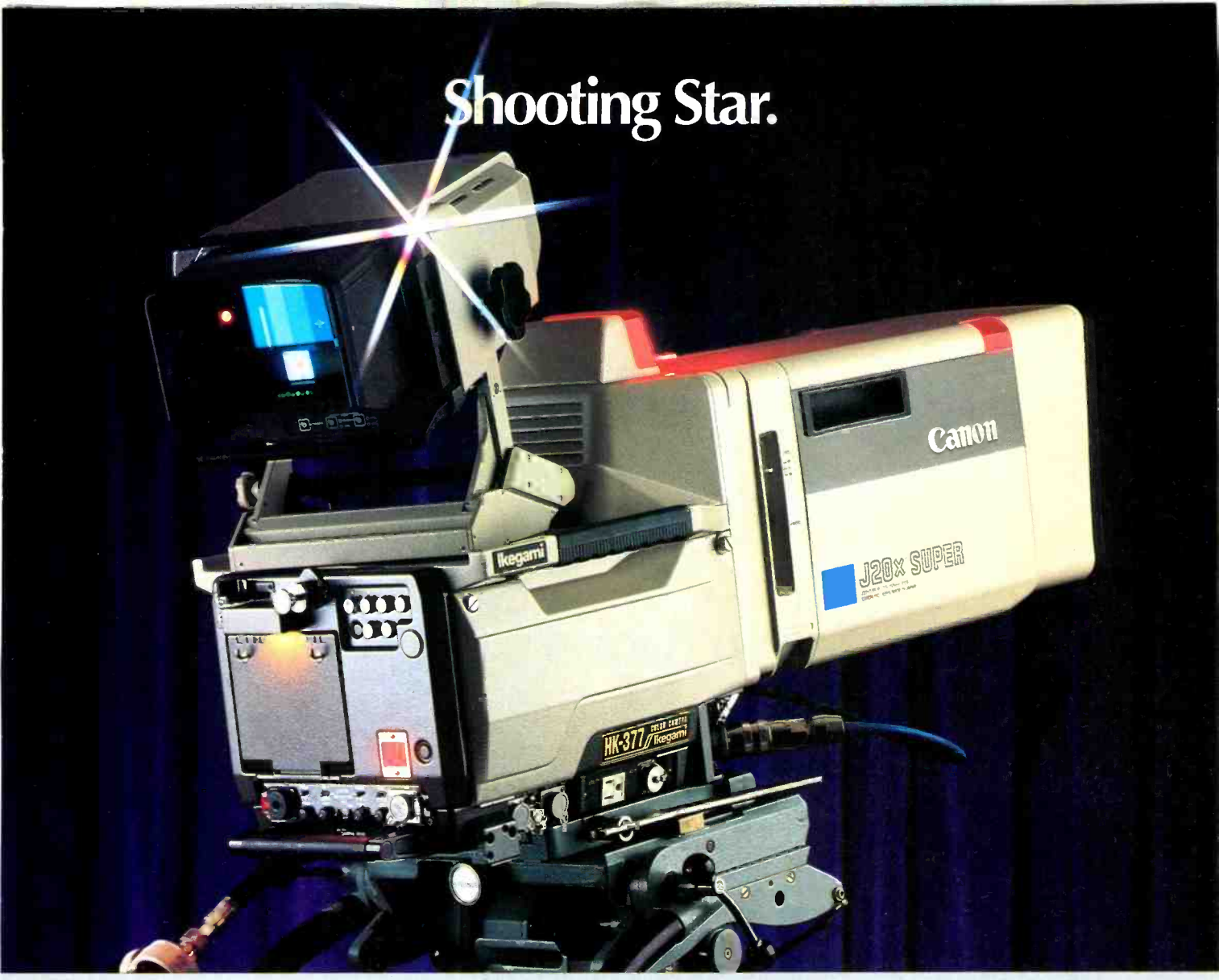
More recently, other methods of MTBF calculation have become adopted for published disk-drive MTBF specifications. These methods predict the failure rate for a family (e.g. large statistical sample) of disk drives, instead of an individual device. The methodologies are typically based on either field return statistics or ongoing reliability testing (ORT). Field return data is either based on statistics collected for similar products (used for a new product), or on statistics for the actual device if it has a significant installed base. However, given the short life cycles of today's disk drives, by the time statistically significant field return information is available for a particular drive, most users are considering using the next generation of drives.

Using field return data for drives with older, but similar technology has merit, but is not without risk. No matter how similar two drives are, there are differences in design and manufacturing processes. These differences may be enough to mask an endemic problem with the newer drive that manifests itself as a higher failure rate. Furthermore, as drives become more intelligent with higher degrees of onboard processing capability, the influence of microcode design on reliability shouldn't be discounted. After all, a drive failure caused by a microcode bug is just as much a failure as a failed circuit or bad bearing. Unfortunately, software problems tend to be insidious and difficult to identify.

Like field return data, ORT is not foolproof. Accelerated life tests, typically involving a sample of drives exercised to their limits under extreme environmental conditions, do not guarantee a correlation between the test results and actual performance in field conditions. No matter how stressful this type of testing can be, it does not subject a drive to the same conditions as does use

Continued on page 44

Shooting Star.



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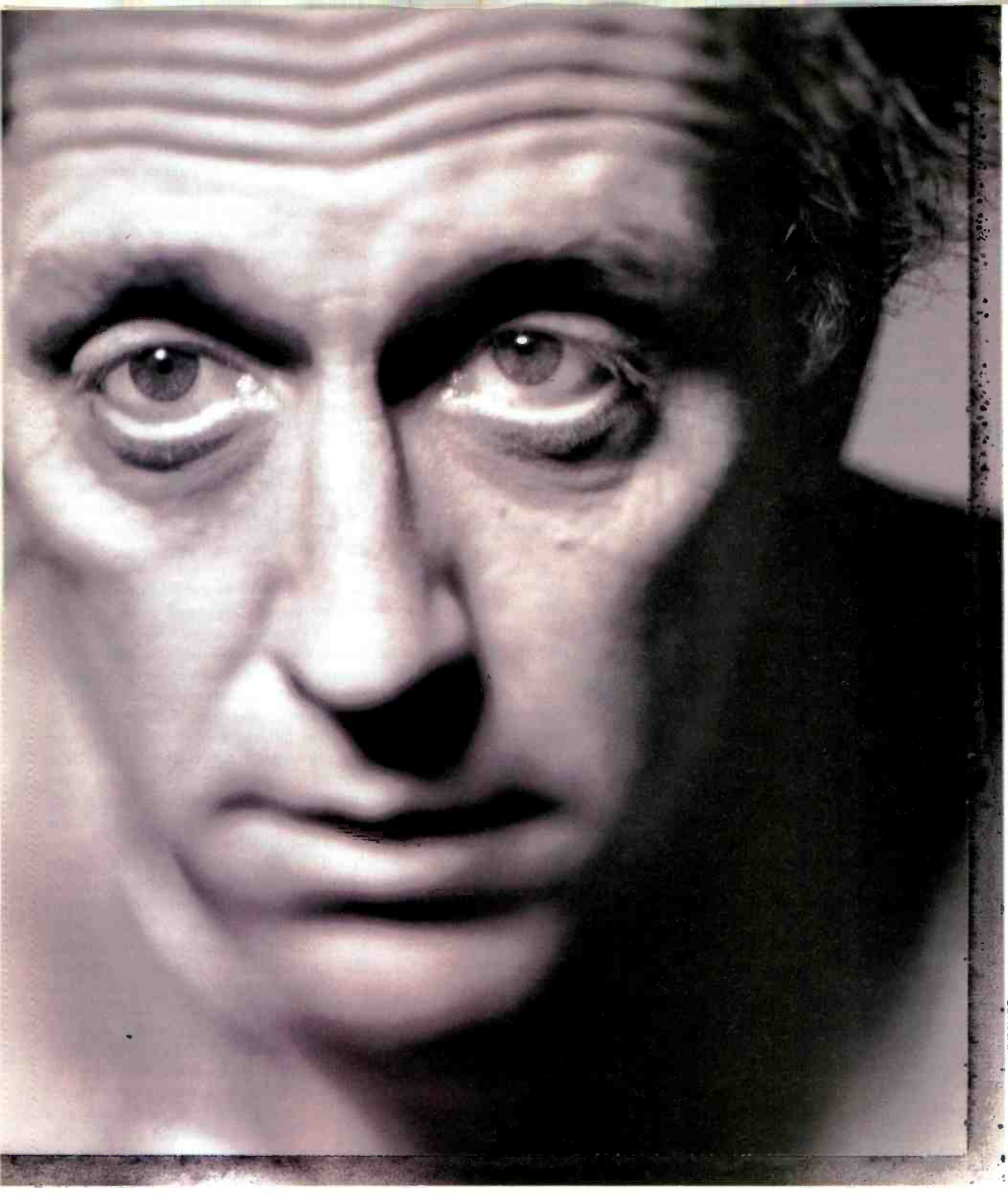

Other stations are way beyond the test phase. Like KOLD in Tucson, where the HP BVS has been on the air for almost a year. And it's about to hit the airwaves in Munich and other major markets around the world.

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Continued from page 40

for an extended time. For instance, even if 500 drives are tested in parallel for 2,000 hours (1,000,000 device hours) there are no assurances an inherent problem won't begin to surface after drives have accumulated 10,000 hours on an individual basis.

Regardless of the methodology used, today's MTBF specifications predict the time between failures exhibited for a family of drives, with no single drive operated longer than its specified service life. The service life of a drive is specified by its manufacturer and qualifies MTBF predictions. With a published service life, time becomes an environmental specification (similar to temperature, humidity, shock and vibration) not to be exceeded if published reliability specifications are to be realized. Today's high-end drives have service lives of five years, which is the typical warranty period. A drive's service life is analogous to the expiration date on a carton of milk. If you always drink the milk before the expiration date (replace a drive at its service life), you'll likely live your life without pouring a glass of spoiled milk (a high MTBF).

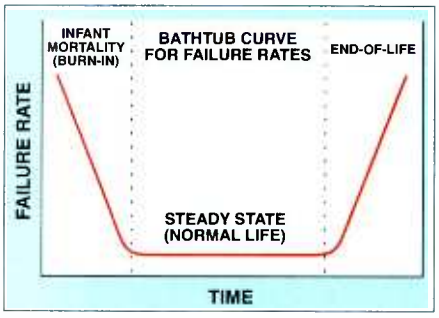

Figure 1. The "bathtub" curve depicts the failure rates of a device over time, from the burn-in phase, in which infant mortality is experienced, to the steady-state period of normal life, to the end-of-life period in which failure rates increase.

Environmental factors beyond time influence actual and specified reliability. When evaluating drives, care should be exercised to ensure the environmental specifications are similar for different drives. Two drives with identical MTBF specifications are not of similar reliability if their environmental specifications are different. For example, if one 1,000,000-hour drive is specified to operate at 50°C and another is only specified to 35°C, the higher-rated drive will have a higher MTBF rating if only operated at a maximum of 35°C. Even when operated within specifications, two identical drives operated with different levels of stress cannot be expected to exhibit similar failure rates. On this, IBM says, "Generally, reliability decreases as temperature increases, so drives that are operated in warm environments with poor airflow will tend to have a lower MTBF than those operated in cool environments with good airflow. Drives that experience a high seek rate tend to have a lower reliability than those that experience a low seek rate."

Multiple drive arrays

The total number of failures a user can expect for a pool of drives in a given period is the ratio of the number of drive hours of operation and the drive's MTBF. This is expressed mathematically with the following formula:

$f \approx (n * s) / MTBF$

where: f = total number of failures

n = number of drives considered

s = hours per drive in period under consideration

MTBF = MTBF of individual drive

Consider a video server application. If a video-on-demand (VOD) server was to store 500 titles on-line, how many disk failures can be expected if the server is operated continuously for a 5-year service life? Assuming each title is two hours long and compressed to a video stream rate of 3Mb/s, each title would require about 2.7GB of storage or 1,350GB for all the titles. With approximately 4.2GB of usable capacity per drive, 321 drives would be required. In five years, 14.1 million hours of operation would be put on the 321 drives. If the drives have an MTBF of 1,000,000 hours, then 15 drives, or nearly 5% of the total, would fail.

If, to achieve a higher video stream bandwidth, 2.1GB drives were used in lieu of the higher-capacity drives, 643 drives would be required. These drives collectively would experience 28.2 million hours of operation during their service life. It follows that 29 drives would be expected to fail.

The distribution of failures over time is generally expected to follow the "bathtub" curve. (See Figure 1.) This type of distribution has a decreasing rate of failure at the beginning of a product's life (infant mortality), followed by a period of steady-state failure, and concludes with an increasing rate of failure corresponding to a bell curve distribution nominally centered at the end of the service life period. While drive manufacturers try to minimize field infant mortality with burn-in testing before shipment, conservative wisdom does not expect new drives to exhibit steady-state failure rates immediately upon shipment. Also, note that the steady-state failure rate is not zero; drives are expected to fail during this period, but the rate of failure is the lowest during the drive's life expectancy.

RAID to the rescue

Video servers are being adopted for a range of applications such as video-on-demand, commercial insertion and on-line editing and playback. A common characteristic of these applications is the need to play back video in real-time. Without redundancy, drive failures in a video server cause interruptions to the video streams being sourced by the server. Fortunately, these interruptions are preventable using a technology called Redundant Array of Independent Disks (RAID).

RAID is designed to provide cost-effective redundancy to groups, or arrays, of disk drives. The technology was originally presented in an academic paper from the Berkeley campus of the University of California. The paper presented five alternative techniques for implementing redundancy. These techniques were referred to as Level 1 through Level 5, otherwise known as RAID-1 through RAID-5. A redundancy technique predating the paper, typically referred to as mirroring, was used as a frame of reference for the other four levels of RAID and was termed RAID-1. This technique duplicated every disk in an array. If one failed, there was another with a mirror image of the first's data. This technique was common in large-scale computing environments such as mainframes. However, mirroring is expensive because the total purchased storage capacity is twice what is required.

The additional RAID levels were devised to lower the cost of redundancy while preserving the redundancy and performance attributes of RAID-1. The underlying principle of lowering the re-

Figure 2. This chart shows the typical storage costs for varying number of compressed (3Mb/s video rate) 2-hour movies. Shown are costs for non-redundant, n+1 RAID and mirroring (RAID-1) configurations.

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dundancy cost is the use of error-correcting codes (ECC) stored on a single disk. The ECC enables a disk array subsystem to regenerate the data that was contained on a failed drive. Because the ECC for an arbitrary number (n) of data disks is stored on a single disk, the cost for redundancy is much lower than with RAID-1 ((n+1) disks for RAID-3, 4 and 5, (2*n) disks for RAID-1). See Figure 2 for a comparison of the relative costs.

The (n+1) RAID configurations (levels 3, 4 and 5) have similar redundancy capabilities, but differ in their performance characteristics. This is due to the techniques used to distribute user data (e.g. digitized video) across the array. RAID-3 uses a byte-striping technique. User data is striped a byte at a time across all data drives. As a result, a RAID-3 array appears to the host as a single disk with a transfer rate equivalent to (n) drives operating in parallel. RAID-3 is ideal for applications that transfer large amounts of sequentially stored data, such as digitized video.

RAID-4 and RAID-5 distribute user data using a block-striping technique. Each block of user data is stored in its entirety on an individual disk. User data is evenly distributed a block (or sequence of blocks) at a time across the data drives. A disk array subsystem using RAID-4 or RAID-5 has the performance characteristics of a multiple spindle configuration, each spindle servicing different user data requests. Because each spindle is independent, the data rate for each request is low, as compared to RAID-3. RAID-4 and RAID-5 are better suited to applications that access small, randomly distributed pieces of data, in which I/O performance is more important than transfer rate. LAN servers and transaction processing are examples of these types of applications. The difference between RAID-4 and RAID-5 is the method used to store the ECC. RAID-4 uses a dedicated disk while RAID-5 rotates the ECC with user data across all drives. RAID-5's write performance is higher because all write requests do not contend for a single disk as in RAID-4.

Because RAID-3 is best suited for video-based applications, the balance of this article will reference RAID-3 for analysis.

RAID's redundancy

RAID provides redundancy by storing an ECC on a separate disk every time user data is written. If a data disk fails, the ECC is used in conjunction with the remaining data to reconstruct the failed disk's data. The ECC is actually a simple parity code applied to the data stored on the data drives.

An analogy illustrates the principle. Each sector of data on each disk is nothing more than a sequence of numbers. Each byte stored on the redundant (or ECC) disk is the simple sum of the same byte position on each of the data disks. If a disk fails, its data can be reconstructed by subtracting from the data stored on the redundant disk the sum of the data on the remaining data disks. The remainder is the data that was stored on the failed disk. For example, if the number 10 is stored on each of four data disks, then 40 is the ECC (10+10+10+10). To reconstruct a failed disk's data, the sum of the remaining data disks, 30 (10+10+10), is subtracted from the ECC (40), yielding the failed disk's data, the number 10. Figure 3 illustrates how user data and the ECC is stored on an array with four data drives.

The redundancy technique employed in RAID allows any single drive (including the redundant drive) to fail without causing access to the data to be lost, known as data availability. The RAID Advisory Board (RAB), an industry organization that promotes RAID technology, defines data availability as "an application's ability to access correct data in a timely manner." For broadcast applications this means a RAID-based video server can sustain a drive failure (or,

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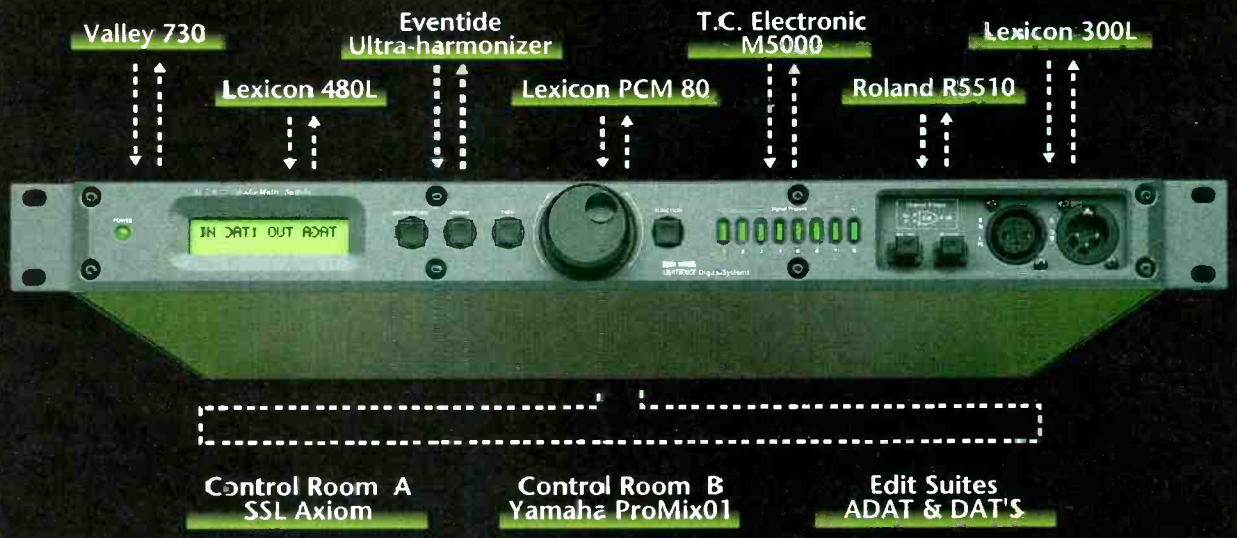

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more precisely, one failure per RAID installed) and still supply video data in real-time for broadcast. In fact, a host accesses (e.g. reads and writes) a RAID no differently after a drive has failed than when all drives are operating. With RAID-3 arrays in particular, there is no performance degradation after drive failures.

The "catastrophic failure" for a RAID array is two simultaneous disk failures. The ECC of a RAID is not able to regenerate the data for two failed disks. However, the principle of RAID says that the likelihood of two disks failing simultaneously is so remote as to be considered negligible. The Berkeley paper presented an analysis that quantified this premise. The metric of concern is the Mean Time until Data Loss (MTDL). MTDL is defined as "the average time from startup until a component failure causes a permanent loss of user data in a disk array." Permanent loss of data occurs when two drives experience failures simultaneously, which, of course, prevents data availability.

USER DATA: (512 bytes/block)				
$A_1 \ldots A_{512}$ BLOCK 1	$B_1 \ldots B_{512}$ BLOCK 2	$C_1 \ldots C_{512}$ BLOCK 3	$D_1 \ldots D_{512}$ BLOCK 4	
4 + 1 RAID-3				
DISK 1	DISK 2	DISK 3	DISK 4	REDUNDANT DISK
A_1	A_2	A_3	A_4	$\oplus$ A_1 .. A_4
A_5	A_6	A_7	A_8	$\oplus$ A_5 .. A_8
:	:	:	:	:
A_{509}	A_{510}	A_{511}	A_{512}	$\oplus$ A_{509} .. A_{512}
B_1	B_2	B_3	B_4	$\oplus$ B_1 .. B_4
B_5	B_6	B_7	B_8	$\oplus$ B_5 .. B_8
:	:	:	:	:
B_{509}	B_{510}	B_{511}	B_{512}	$\oplus$ B_{509} .. B_{512}
C_1	C_2	C_3	C_4	$\oplus$ C_1 .. C_4
C_5	C_6	C_7	C_8	$\oplus$ C_5 .. C_8
:	:	:	:	:
C_{509}	C_{510}	C_{511}	C_{512}	$\oplus$ C_{509} .. C_{512}
D_1	D_2	D_3	D_4	$\oplus$ D_1 .. D_4
D_5	D_6	D_7	D_8	$\oplus$ D_5 .. D_8
:	:	:	:	:
D_{509}	D_{510}	D_{511}	D_{512}	$\oplus$ D_{509} .. D_{512}

Figure 3. User data is striped a byte at a time across the data drives in a RAID-3 configuration. The redundant disk contains an ECC calculated using the logical exclusive-OR (parity) operator applied to the data stored on all the data disks. This ECC, when combined with the data stored on any three of the data disks, generates the data for the fourth disk.

MTDL

Like MTBFs, MTDLs are predictions based on statistical probabilities. There are no guarantees that two drives won't fail simultaneously. But because the risk for RAID is so low, there is little justification for pursuing the more costly methods of redundancy that tolerate multiple simultaneous drive failures. The variables in predicting the MTDL of a disk array include the reliability of the drives, the number of drives, and the time to replace and regenerate a failed drive. The Berkeley paper derived the following formula for predicting the MTDL of a RAID disk array:

$MTDL = (MTBF)^2 / ((D + C * n) * (G + C - 1) * MTTR)$

where MTBF = the drive's MTBF,
D = total number of data drives,
C = number of redundant drives per rank (for RAID-3, C = 1),
n = number of ranks (typically n = 1),
G = number of data disks per rank (typically G = 4 or 8),
MTTR = time to replace and regenerate a failed drive.

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System 3000 also gives broadcasters additional capabilities including the ability to broadcast up to 18 video channels within a single satellite transponder, statistical multiplexing and various telecom networking capabilities.

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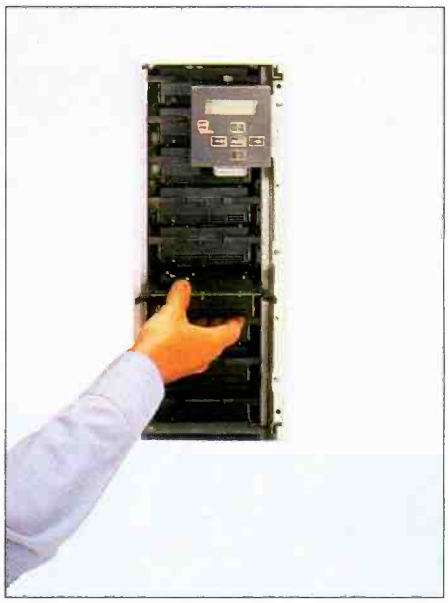

The disks in many RAID arrays are mounted on disk shuttles. The shuttle allows for the hot swap of a failed disk. Once swapped, the controller can immediately begin rebuilding the lost information.

An example based on a typical RAID implementation will show the extremely low probability of two simultaneous drive failures. A typical RAID-3 has four data drives and one redundant drive (e.g. 4+1) configured in a single rank of drives (a rank consists of the data and redundant drives grouped together to form a logical disk). Most users will conservatively replace and regenerate a failed drive within 24 hours (much quicker in many cases). Published disk MTBF specifications are around 1,000,000 hours for high-performance disks. Plugging these values into the Berkeley formula yields: MTDL = 2.08 billion hours = 237,823 years!

Given the earlier analysis of disk MTBFs, a more conservative approach to calculating MTDL substitutes the disk's service life (43,800 hours, typical) for MTBF. In the example, the calculated MTDL drops from an astronomical 237,823 years to a still extremely high 456 years. Regardless, the probability of an individual RAID suffering a "catastrophic failure" is so remote that this technology can be used with confidence in the real-time world of broadcast.

Hot swapping — key to high data availability

In addition to requiring real-time access to video data, broadcast applications often require round-the-clock operations. In this paradigm, servicing a failed disk must not result in downtime. RAID implementations designed to operate in this environment allow users to hot swap failed drives. Special packaging, typically involving a disk shuttle, is incorporated in the array subsystem. The shuttle card slides in and out of the

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array on card guides, much like a printed circuit board. The cards typically plug into a drive backplane that connects the drive shuttles and RAID controller. This approach eliminates internal cabling, a source of failures.

Once a failed drive has been replaced, the RAID controller rebuilds onto the replacement the data originally contained on the failed drive. The controller reads a portion of the remaining data disks and the corresponding location on the redundant disk. With this information, the failed disk's data is regenerated and written to the replacement disk. The process proceeds iteratively until the replacement is completely regenerated. At this point, 100% of the array's redundancy capabilities have been restored.

Disk drive bandwidth is consumed during the rebuild procedure, reducing the maximum user load the array can support. Because of this, most users schedule rebuilds to off-peak hours, when the array normally isn't running at full bandwidth. This way, the array can simultaneously rebuild a replacement disk and service a lower user demand without a degradation in performance.

Hot swap power

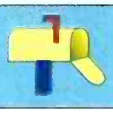
Disk arrays can provide redundancy in other components. Power is a good example of this. Many RAID products support hot swap redundant power supplies. However, caution should be used in evaluating redundant power implementations.

Two basic types of redundant power include load-sharing supplies and disk-mounted power supplies. The load-sharing approach uses a technique similar to the redundancy used for the disks themselves. An extra power supply is added to the base number of supplies required to power the array. The gang of supplies share the total power load. If one of the supplies fails, the remaining supplies are adequate to continue powering the array. There is no interruption to service with this approach. Furthermore, there is no linkage between power and disk failures. An array can simultaneously experience a disk and power supply failure with no decrease in data availability. Because the power in this approach is used for the entire subsystem, power redundancy is available for all disk array components such as fans, controllers and displays.

Small, disk-mounted power supplies are the other standard form of redundant power. In this scheme, a power supply failure causes a disk failure. The power supply failure is serviced by replacing the disk/power unit as though it were caused by a disk failure, not a power supply failure. Unlike the load-sharing power supplies technique, here there is a linkage between power and disk failures. As a result, a disk array using disk-mounted power cannot simultaneously experience a disk and power supply failure. This condition would be equivalent to two simultaneous disk failures, the "catastrophic failure" for a RAID array. Furthermore, while this scheme provides power redundancy for the disks, it does not provide power redundancy for other array components.

The reliability of disk drives has improved over the past several years. During this period, disk manufacturers have changed the methodologies used in calculating the MTBF specifications they publish for their disk products. As a result, published MTBF figures have risen by at least an order of magnitude. Upon closer examination, the actual increase in disk reliability is much less. The increase in MTBF is attributable to the change in methodology used to calculate MTBF predictions. Users also need to adjust their interpretation of MTBF specifications. This will show that drives are more reliable, but are by no means failure-free. ■

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



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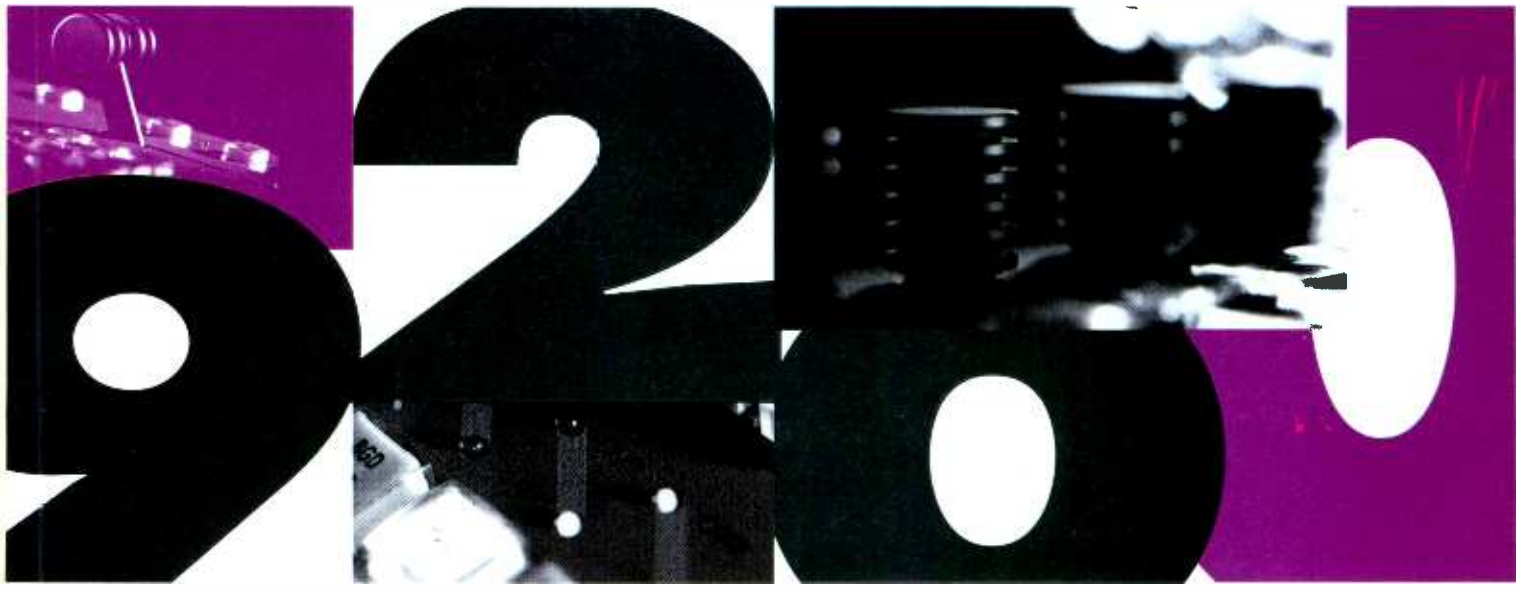

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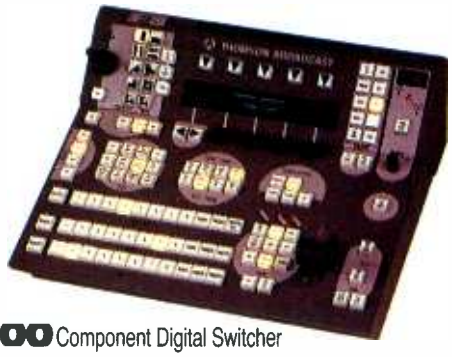

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Optical storage solutions

By Richard Bauarschi

As storage choices broaden, the application, rather than the technology, can become the defining factor.

The Bottom Line:

There was a time in broadcasting when being new or better was reason enough to adopt a new technology. Today, engineering is much more pragmatic. When deciding whether to adopt new technologies, many times the deciding question is: "Will it save money and what will be the return on this investment?" $

For many years, storage costs have been part of the day-to-day routine of broadcasting. Tape wore out and you always needed more. The dynamics of video storage have changed over recent years, with new technologies adding flexibility and confusion. This article explores the potential cost savings and revenue opportunities of a new high-density, organic-dye-based write-once, read-many (WORM) drive, the digital laser disc (Digital LD).

Storage decisions

Not all storage systems are created equal. Many systems read and write data using magnetic energy. With videotape, heads mounted in a spinning drum penetrate into the oxide and binder system of moving tape. Videotape is the least-expensive medium for recording a full-bandwidth video signal, but there is still a price to be paid. The constant friction of the tape means periodic replacement of the heads and guides. Also, the mechanical alignment of the tape path is critical. To maintain reliability, videotape machines require much attention. A sizable maintenance budget must be added to the cost of videotape storage to find its true cost.

The hard-disk drive (HDD) found in most computers also uses a magnetic recording process, but it is somewhat more durable. The head is designed to hover close to, but never touch, the whirling media. To reduce foreign particle contamination that could lead to head crashes, HDD manufacturers seal the heads, platters and drive motor in a metal enclosure. This keeps HDD reliability high, but it also causes one of its major drawbacks: The media is captive. If something goes wrong, the data can be lost. With videotape and optical discs, on the other hand, the recording medium is removable. It can be quickly pulled from one machine and transferred should problems develop with the playback system.

Optical disc systems

There are several optical disc processes. The phase change and magneto-optical (MO) systems use lasers to apply heat to a thin layer of rare-earth transition metals. In MO systems, a laser heats a tiny patch of the disc to a temperature called the curie point (about 200°C). At that point, a relatively tiny magnetic field can change the magnet polarity of the heated area to record data. At playback, polarized light is beamed at the magnetically polarized surface. The phase angle of the reflected light varies according to the polarization surface, thereby accurately reproducing the input datastream.

In the phase change system, variations in the power of the heating laser cause the metal to go to either an amorphic or crystalline state. The scanning laser will then either be defracted or reflected, representing the binary states of the input data.

Both these systems use metal, which is a good conductor of heat. Laser spot size and duration must be carefully controlled to avoid disturbing the neighboring data, effectively limiting the track pitch, and therefore, capacity.

Non-metallic disc recording systems are also available. These can be printed systems, such as CDs and CD-ROMs, or they can be dye systems. In a dye system, laser light is pulsed onto a thin spin-coated layer of organic dye. The heat changes the dye's surface characteristic, forming a pit. A scanning laser will be reflected when it contacts a pristine surface area and defracted when it strikes a pitted area. The dye is not a good heat conductor, and therefore, pit spacing and track pitch can be much tighter. A double-sided 12-inch Digital LD can hold 19GB of information, about three times the amount that can be stored on MO or phase change discs.

Dye-based discs are write-once, read-many (WORM) devices. For many applications, such as archives and on-line libraries, this can be advantageous. It provides intrinsic write-protection and unlimited random-access playback.

Reliability factors

Digital LD players are designed with few moving parts. Actuators move the optical heads across the disc while a spindle motor rotates the disc at the

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proper velocity. Maintenance consists of keeping the unit dust-free, although for highest reliability, it is also recommended that the spindle motor be replaced annually. The media is sealed between polycarbonate discs, and because it is touched only by a beam of light, it is not affected by frequent use.

Media costs over the life of a system are a key factor in determining the overall system price. The most expensive of the three media discussed are the hard-disk drives. On the other hand, they are purchased only once, and operated until they break down. The least-expensive media is videotape, but it also has the shortest life. Digital LDs cost more than videotape, but they can be used heavily without degradation.

This is only half of the story, however. As the equipment we are contemplating will be in service for several years, we would do well to consider what prices may do in the future. The price of hard-disk drives is descending approximately according to Moore's Law. This axiom of the computer industry states that the amount of electronic memory you can get for a certain price doubles every 18 months. By corollary, prices for a fixed amount of memory halve in the same period. There will be a limit to how far HDD prices can drop. Thereafter, it is likely that HDD capacities will increase, but prices will remain constant.

Digital LD prices will also descend as their volume increases. However, the Digital LD, being polycarbonate and porfine, is far simpler than hard drives.

The transport mechanism of the Digital LD is shown above. On this unit, one optical pickup is used for playback and the other is for record. Units can be configured for up to four simultaneous output channels from a single side. A 2-pickup unit can provide outputs from both sides. However, only one pickup at a time can be used because the disk rotation must be reversed.

Demand for videotape may decrease as emerging non-tape alternatives enter the market. If the volumes fall, prices may rise. Although tape and Digital LD prices may not cross each other directly, by factoring in upkeep and replacement cassettes, the long-term cost difference may be minimal.

Environmental expenses

Special environment costs must be considered. Hard-disk systems can operate in any environment suitable for office workers because the media is in a protective enclosure.

Videotape machines work best in a controlled environment, and tape vaults are needed to keep archived videotapes at a constant temperature and humidity. Because the tapes should not be exposed to water, the building sprinkler system must often be replaced by special fire-suppression equipment.

The Digital LD system can operate in environments suitable for either videotape machines or computers. The media, however, is much more durable. It is specified for storage at just below boiling and somewhat below freezing. Submersion is not recommended, but will likely cause little or no damage. The discs can sit on the shelf until needed, although the robotic changer is greatly preferred because it keeps discs at the ready, but provides physical protection as well.

Modular expansion

There may be hidden costs in stepping up or down system capacity. Videotape is modular. Tape machines can be added or subtracted as required. All that is needed is to adjust the work schedule to provide personnel to keep the machines loaded and repaired. Hard-disk drive storage can be harder to step up or down in volume. Changing array sizes may require a reload and re-striping procedure.

Extremely large systems of tape machines or tape machines that must access large libraries, are enhanced by robotics. The Digital LD system is most efficient when used as part of a robotic storage system. A system of 225 discs and two drives can store almost 5TBs. At this level, the cost per GB is much lower than that of hard disks, and approaches videotape.

Revenue matters

It has become increasingly important for facilities to consider additional revenue streams, not just operate more efficiently. One resource that stations often turn to is their own archives, especially news. Providing fast, easy access to news libraries allows producers to create additional programming inexpensively. Organizations with extensive news archives have also sensed the potential profit in allowing outside customers to access their archives. This initial activity may be the seed from which stations develop revenue streams in on-line services, NVOD applications, second-channel digital programming services and National Data Broadcasting Services (NDBS).

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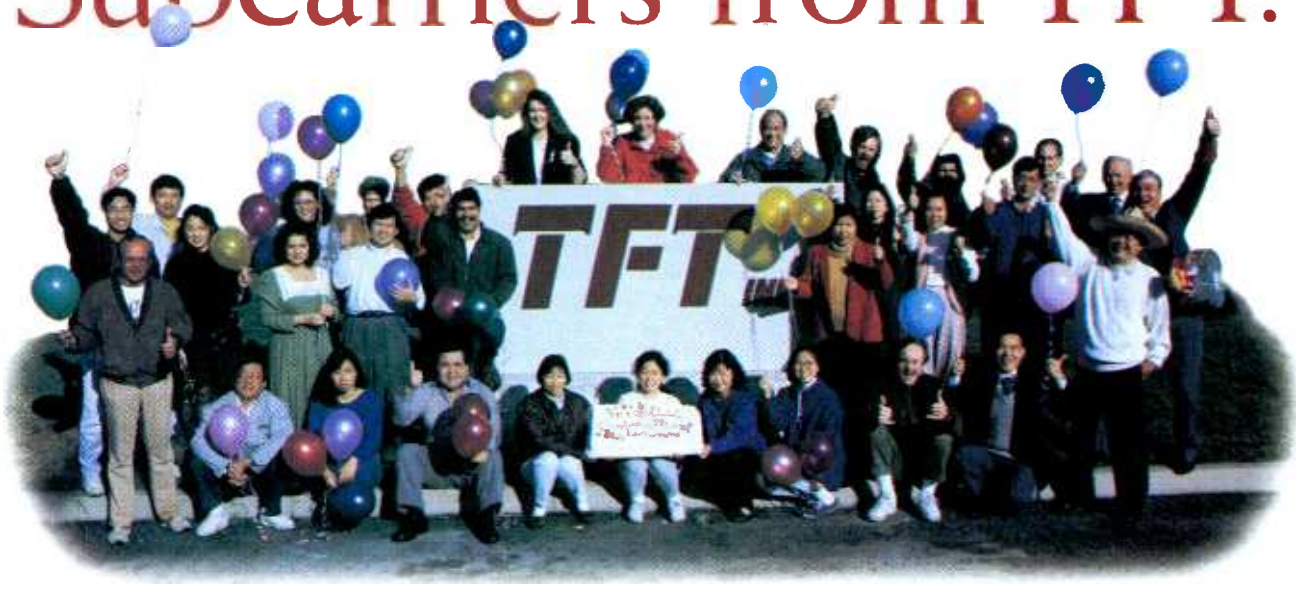

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Most archives are already videotape, so we will discuss the advantages of electronic archival. First, the entire library is available without having to employ someone to pull tapes and load machines or having to keep machines of various formats running. Second, putting archives on the station server gives all users access to programs within a reasonable period. With videotape, if one user has a cassette, no one else can use that tape until it is re-shelved. Finally, some archive material is fragile. As access is increased, irreplaceable tapes may be damaged.

Archives are meant to be read, not written. The most successful applications of this technology will be those that combine the advantages of Digital LD with the strengths of tape and hard-drive systems. Experience with a few such scenarios will likely fuel the vision for even more effective combinations. ■

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Stand-alone VDR

By Steve Epstein, technical editor

For those who would like to take advantage of disk technology, but find that the support computers are either too costly or simply take up too much space, the Video MOD-100 from Rorke Data may be just what you are looking for. The unit is smaller than a typical VTR, requires no additional support equipment and has removable media.

Depending on your needs, the unit can be purchased with either a 1.3GB magneto-optical drive or a removable hard drive. Video is stored in a Motion JPEG or MPEG (optional) format. Two channels of 8/16-bit audio is also provided. Depending on the quality required, from 80 minutes of off-line quality to 32 minutes of S-VHS quality can be stored on each 1.3GB magneto-optical disc. For even higher quality levels, up to 54 minutes of Betacam/MII quality can be recorded on a removable 4GB hard drive. Both drive systems can be expanded to up to seven drives using a SCSI connector on the rear panel.

What really makes this unit unique, is that all functions are accessible from the front panel. An RS-422 serial port is provided for easy integration into existing facilities and the unit has built-in LTC/VITC synchronizing capabilities. For film applications, a film-style remote is also available. ■

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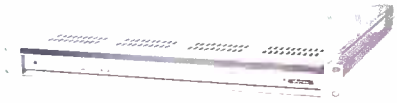

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Hard-drive technology

By James Frantzreb

As capacity and throughput increase, hard-drive technology is finding its way into more and more areas of broadcast and post-production.

The Bottom Line:

Revolutionary changes in video storage systems have brought about new equipment categories, including non-linear editors and video servers. These changes, coupled with the increased availability of sophisticated computer hardware and software, are changing the face of broadcasting. Understanding the basics of these new systems will facilitate the decisions necessary to move facilities into the next century. $

As non-linear media production and distribution technologies find acceptance in the broadcast industry, broadcasters have become more and more dependent on storage products for reliable, cost-effective operations. The central element of non-linear storage is the hard-disk drive. This device plays a critical role in non-linear editing, distribution, archiving and even acquisition.

Today's Winchester disk drives, commonly known as mag disks or hard drives, consist of a stack of rigid platters, coated with a magnetic material; read/write heads (generally two for each platter); mechanical assemblies for moving the heads and platters; and sophisticated electronics. At the highest level of abstraction, these components combine to determine four technical elements of interest: sustained data transfer rate, capacity per device, form factor and mean time between failures (MTBF).

Disk-drive performance

Broadcasting applications such as commercial insertion, news editing and on-line video libraries, where extremely large amounts of randomly accessible video are needed instantaneously and in continuous streams, push drive performance to the limits. For these video applications, the most important aspect of disk-drive performance is the ability to produce high-speed, sustained and uninterrupted data transfers. Transfer rate is a measure of how quickly the drive can deliver a datastream measured in megabytes per second. Many other performance specifications typically are reported with any given hard drive. These include seek time, access time, media data rate, burst transfer rate and read channel bandwidth. Although interesting on their own merit, they all combine with the drive's firmware to produce a characteristic overall performance level.

Today's JPEG-compressed, broadcast-quality video streams require at least 4MB/s, including two channels of audio sampled at 44kHz. While the data rate demanded by a single video/audio stream varies relatively little, the transfer rate from the drive varies based on the data's physical location. Specifically, data stored closer to the center of the platter (the inner diameter or ID) cannot be transferred out as rapidly as data at the outside diameter (OD). For this reason, overall transfer rate is expressed as a range or an average. Broadcasters must ensure that the slowest part of the drive is capable of sustaining an appropriate data rate for the most demanding material.

Firmware modification is another critical component of the sustained data rate equation. Most data-processing applications require fast access to relatively small chunks of data and are premised on the belief that the drive can and will be idle frequently. As such, hard-drive design incorporates heavy use of error correction and does not provide for instant and uninterrupted access to the data. For data processing, a slight delay of the data is acceptable, but losing a single datum is not. With digital video, however, it is acceptable if some pixels are not optimally resolved or drop out completely as long as the datastream is not held up. Disk-drive firmware can be optimized for video by adjusting error correction schemes and eliminating non-interruptable "housekeeping" activities.

The final element of the data transfer pipeline is the external device interface, primarily, small computer systems interface (SCSI). SCSI defines a communication and interface standard for desktop peripheral devices that is being increasingly adopted on higher-end equipment. Fast-wide SCSI, currently the most common high-performance disk interface, allows raw bus bandwidth rates of up to 20MB/s. New SCSI implementations will reach up to 40MB/s, and serial SCSI architecture (SSA) and fiber channel-arbitrated loop interfaces promise to bring raw bus bandwidth to 100MB/s and beyond. All together, these factors account for leading-edge, single-drive performance in the 4.5 to 7MB/s (ID to OD) today.

Disk-drive capacities

The amount of data that can be stored on a hard drive is a function of platter capacity and the

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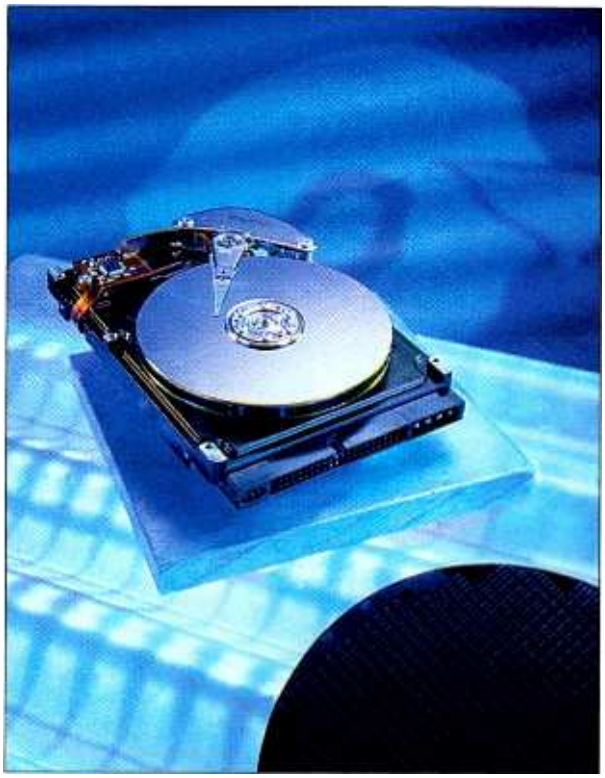
number of platters in the drive. Platter capacity, in turn, is a function of a platter's "areal density" measured in bits per square inch, and the platter's diameter. For any given diameter or drive form factor, areal density is increasing at the staggering rate of 60% per year. This is the primary reason for the incredible price/performance/capacity gains in hard-disk drive storage. It is being driven by evolutions in read/write head design, platter design and read channel (electronics) technology.

Today, most disk drives use thin-film inductive heads to read and write on the platters. Although inductive head technology is capable of up to about 500 million bits per square inch, the trend toward smaller disks with an increased areal density is taking its toll on thin-film technology. Thin film heads have been proven to work well, but the linear velocity of smaller disk's inner tracks are too low to produce an adequate signal for an inductive head. As tracks become more compressed, the signal is attenuated, making them unreliable for higher-density applications.

A newer head technology, and one currently in use by IBM and other manufacturers, is called magneto-resistive (MR). MR heads deliver significant increases in areal density, reliability and performance. The major advantage of MR heads is a superior signal-to-noise ratio.

For 30 years, the electronic method for detecting the bits on the surface of the media has been the peak detect method. This is a technique in which peak values of transitions are detected through an analog circuit. One major drawback is that noise spikes can be mistaken for signals, and signals can cancel each other out. As such, peak detect is gradually being replaced by partial response maximum likelihood (PRML), which digitizes the incoming transition stream before detection. Because these signals can be stored, the pattern of a sequence of signals can be used to determine the signal value, and the need to use an instantaneous peak to detect a transition can be eliminated. Using MR heads and PRML channels, IBM holds the current areal density record of 644Mb/in^2. According to IBM, MR heads will sustain an increase of 60% per year in areal density at least until the end of the decade. These areal densities currently allow 9GB per drive on the 5.25-inch form factor products and 4.3GB on the 3.5-inch drives. The next generation of technologies will push these capacities to 18+GB and 8-10GB, respectively.



A 3.5-inch form factor hard drive. Current models offer capacities up to 4.3GB. Future units are likely to offer capacities in excess of 8GB.

Reliability and enhancing drive performance

As described earlier, the hard drive is an electromechanical device. It is subject to mechanical wear and failure over time. Furthermore, it is an integrated storage device in which the electronics, mechanics and media cannot be easily separated. These two factors combine to make the reliability of hard drive subsystems a key consideration in the specification decision. Manufacturer MTBF claims are difficult to verify and, at the end of the day, are simply average statistics for large populations of product. Caveat emptor — individual experience may vary substantially from published specifications. In addition, when multiple drives are combined in a subsystem to store data as a single unit, MTBF decreases substantially with the additional components. Certain performance improvement schemes, such as disk striping, point this out.

As fast as disk drives are, they are still not fast enough for the demands of multiple stream or uncompressed NTSC, which can require up to 33MB/s per stream. In these cases, where throughput greater than that obtainable on a single drive is essential, disk striping is a good solution.

With striping, a software utility or hardware controller divides the incoming datastream between two or more drives, so the drives operate in parallel. The disadvantage is the reduced MTBF that results from using additional drives. Unless the media is backed up, a drive failure can wipe out everything. Even with backups, users are faced with the time it takes to restore the data.

Because loss of data is unacceptable, broadcasters have turned to RAID storage. (See "RAID Storage Technology," p. 40.) With RAID, a parity bit is generated by a RAID controller and included along with the striped data. In the event of a disk failure, missing data is determined on the fly with no effect on the output video. Once the defective drive has been swapped with a new one, reconstruction of the data on the new drive is done automatically by the RAID controller.

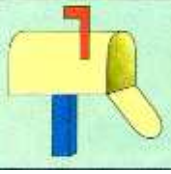
Additionally, by migrating infrequently used data from their disk drives, broadcasters can free valuable space and maintain optimum hard-drive storage performance. Software tools, called hierarchical storage managers, can be used to automate the process of analyzing data usage and migrate frequently used data to faster devices and less-requested data to slower devices.

Disk-drive considerations

Hard-disk technology is increasingly becoming an important component for production and playback in broadcast. As station operations migrate to the next-generation facility, disk-based systems will provide high performance, capacities and speed for mission-critical storage. Key features to consider before purchasing hard-disk storage subsystems include:

1. Does the storage subsystem get the job done reliably and at an appropriate cost over its lifetime? The unit must be heavy-duty, reliable, maintainable and cost-effective.
2. Will the vendor support the storage subsystem? Despite claims to the contrary, disk drives running at the edge of their performance envelope and at the limit of the SCSI specification are not commodities. The storage subsystem provider should be able to troubleshoot overall system problems because the user may not be capable of determining the root cause of a problem. On-site maintenance, strategic spares and overnight replacement programs should also be available. ■

James Frantzreb is a senior product manager for storage products at Avid Technology, Tewksbury, MA.



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Digital audio workstations

By Skip Pizzi, technical editor

Non-linear production is moving into the audio room, too.

The Bottom Line:

The advantages of hard-disk recording, non-linear editing and virtual multitracking are a hard combination to beat. That's why digital audio workstations are becoming so popular in the broadcast and post-production environments. But their use and integration into the TV production facility takes some special skills. $

Above photo: The Otari RADAR is a stand-alone, expandable hard-disk recorder supporting 8, 16 or 24 tracks.

Digital audio workstations (DAWs) have been in use for more than a decade, but many in the broadcast production environment have yet to take the plunge. Recent improvements in reliability, speed and cost-effectiveness are rapidly dissolving this reluctance, however.

The advantages of DAWs in broadcast post-production are fairly obvious. The ability to conform audio to last-minute picture changes is what first put DAWs on the map for video and film post. The speed and convenience with which they handled this perennial problem made them worth their weight in gold to the post-production community. Since then, prices for DAWs have fallen dramatically, making them more attractive to a growing range of users. In fact, price has become a primary reason for purchasing DAWs. In many cases, they can replace the bulk of a whole suite of conventional audio production equipment at a fraction of the cost.

Plugging into the video world

The most video-specific element of DAW applications is, of course, audio-video synchronization. Although by no means elementary, this process is often simpler and more reliable with the non-linear media used in DAWs than it is with tape-based audio systems, either analog or digital. Most of today's DAWs — even basic systems — offer some level of video synchronization ability, typically via trigger- or chase-lock to SMPTE time code. Synchronization is available on many basic models via optional hardware and software. On more sophisticated systems, this capability is integral and its operation can be quite comprehensive. Among these advanced features are the capability of following time code at non-standard or variable speed (typically +/-10%), scrubbing/shuttling to time code, generation of time code at various rates and forward/reverse chase-lock.

Some of the more heavyweight systems also offer machine-control interfaces, allowing the DAW to serve as master or slave to VTRs and other video-production devices. Most of these use RS-422, typically under the Sony 9-pin protocol, but others are also offered. Some systems can control multiple devices simultaneously and independently. A few DAWs offer full VTR emulation capabilities for direct interface to video editors. These systems often include integral support of several popular editors' EDL protocols.

The ability to conform audio to last-minute picture changes is what first put DAWs on the map.

In some sophisticated production environments, it's also important to synchronize a DAW to other digital *audio* devices. This will allow smooth audio interfacing in the digital domain, typically via the AES/EBU format. For this purpose, higher-end DAWs offer word-clock (or AES/EBU-clock) synchronization. For music production, synchronization to MIDI time code (MTC) is also possible on many units.

A final level of DAW interface with post-production involves integration on the non-linear level. A few DAWs support interconnection with video disk recorders or non-linear editor/production systems, allowing video and multitrack audio to be manipulated fully digitally and with random access capabilities. Some of these systems also allow synchronized video workprints to be copied to hard disk on the DAW, so that off-line audio production and sweetening can continue in an audio-only environment, while retaining the advantage of a synchronized picture for reference throughout.

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Compatibility

Loading audio on and off a DAW's hard disk has always been a point of contention in broadcast production. Today's systems ameliorate this difficulty with a number of different methods to handle audio I/O.

Upload and download of audio to a non-linear recorder can be handled in either of two basic fashions: via *real-time audio* connections or via *file-based transfer* from another non-linear system. The latter typically can take place at some fraction of real time, although in file exchanges over narrow-bandwidth transmission paths, the transfer can actually take up to several *multiples* of the file's actual running length.

Real-time audio I/O on DAWs can be handled in the analog domain (usually with standard balanced +4dBu signals), or on most systems, in the digital domain as well (typically via AES/EBU or S/PDIF standard interfaces). Some advanced systems now allow this real-time uploading and downloading to take place as a background operation, while production continues on previously loaded files.

File-based transfer is less standardized because each DAW uses its own file format. Transferring audio files between like-model DAWs is, therefore, relatively simple via disk or LAN, but the process is far more complex between differing systems.

Loading audio on and off a DAW's hard disk has always been a point of contention.

Such cross-system file transfer is now becoming easier, however, because of a number of recent developments. One is the *Open Media Framework* (OMF), developed cooperatively between a number of major non-linear system manufacturers. It defines a common file format that is supported by a growing number of DAW systems, such that files can be interchanged across systems with the retention of audio material and editing/control/auxiliary data elements. Some systems read OMF files directly while others perform conversions. In this respect, OMF is to audio what ASCII text is to word processing (although most audio "formatting" details are retained with OMF).

Other file-exchange or common sound file formats (within platform types) also exist. In the PC/Windows world, the .WAV file is most common, while .AIFF is preferred in the Macintosh environment and .AU is popular among UNIX users. Utilities now exist in the PC and Macintosh world for conversion between some DAW file formats, similar in function to the file conversion software that exists for word-processing applications.

OMF is to audio what ASCII text is to word processing.

As for full networking of DAWs (beyond simple audio file exchange), a number of systems allow interconnection via LAN. Typically, only systems of the same manufacturer can directly communicate in this fashion, however. In some instances, standard (Ethernet-type) networking is used to connect workstations, while in other cases, the manufacturer has developed a proprietary, high-speed network architecture.

System types

Digital audio workstations come in two basic flavors — those made to operate on general-purpose desktop-computer plat-

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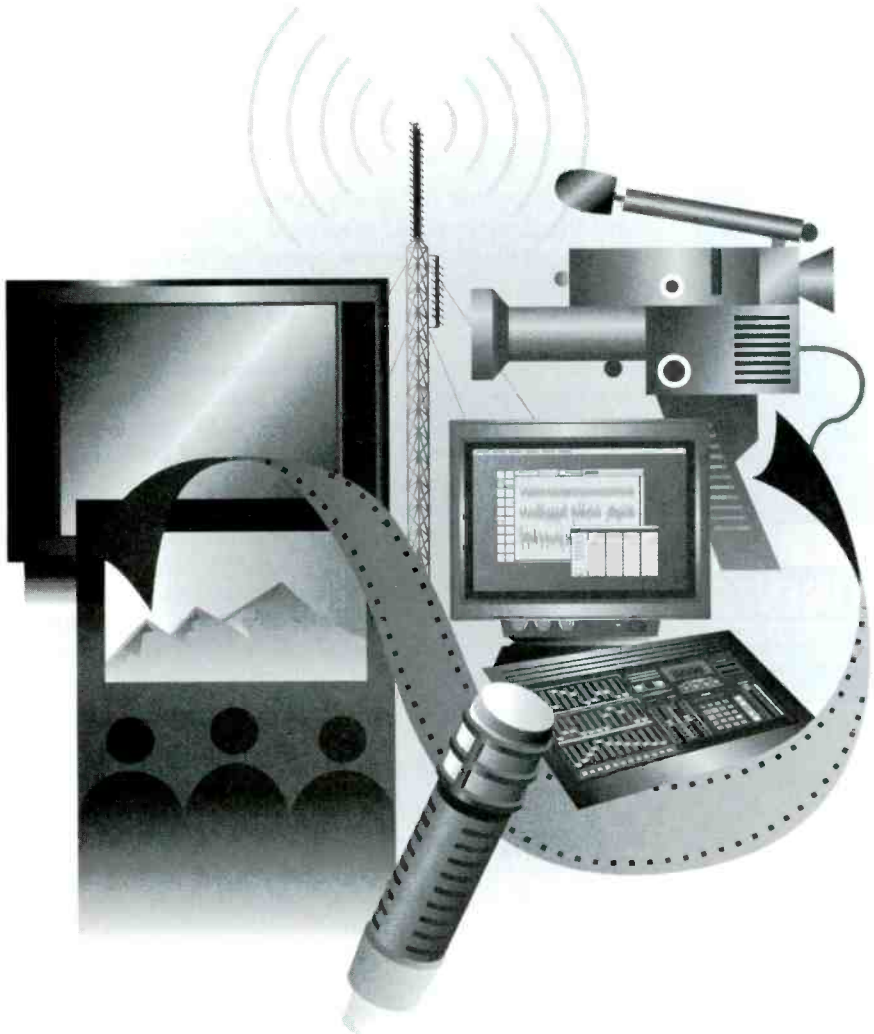

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Avid's AudioVision is an example of a DAW that includes synchronized random access video playback.

forms and those that use entirely dedicated, proprietary hardware. Among the general-purpose varieties, a number of systems use the Macintosh platform and several operate on IBM-compatible PCs.

Each of these categories also exhibits a range of system costs and capabilities. Both low-end and high-end products exist for the Mac, IBM and proprietary platforms.

High-end proprietary systems predominate in the largest post-production houses, while most other production environments use high-end and midrange Mac-based systems. TV stations have begun to implement the low-end Mac- and IBM-based DAWs, along with a few of the low- and midpriced proprietary systems.

Continuing DAW and computer-platform development stretches the pricing spectrum ever wider, so that today's non-linear audio production can be conducted on systems that range from less than $2,000 to more than $200,000. Facilities' and clients' requirements will dictate which system is appropriate, but as price/performance ratios continue to improve, engineering managers have to constantly re-evaluate their directions and decisions.

Non-linear audio production can be conducted on systems that range from less than $2,000 to more than $200,000.

At the low end, the sound boards on multimedia desktop computers — or the native hardware available on the newest Mac and PowerPC platforms — allows the purchase of "software-only" DAWs for as little as $500 for virtual 4-track or 8-track editing and mixing capability. Audio processing (non-real-time) is available for a bit more, as are more tracks.

At the high end are many more inputs, outputs and tracks, simultaneous playback/mixing of a large number of virtual tracks, and powerful real-time audio processing (including equalization, compression/limiting, reverberation and time compression/expansion). Many of these systems also offer fully automated operations, high-speed networking to facility servers, comprehensive synchronization and machine control/emulation capabilities (including integral non-linear video support), and hardware control surfaces, such as real faders (including moving-fader automation), continuous turnpots, transport controls and LED/LCD/fluorescent metering panels. This control-surface hardware is often supplied in a small set (e.g., eight faders on a compact console) that is assignable to a much larger number of actual tracks (e.g., 192 virtual tracks and 32 real inputs/outputs).

Between these two extremes are quite a few variations on proprietary and general-purpose platforms. Some of these intermediate systems are finding life increasingly difficult, however, as the market seeks out products that provide either the most power or the greatest value.

New directions

Recent developments have heightened this race to be either best or best-priced. One important feature in this regard is the inclusion of data-compression capabilities on some DAWs. This allows increased storage densities such that four to six times more audio data can be recorded on a given hard disk. (The standard metric of 10MB/min of full-fidelity stereo audio can thereby be reduced to less than 2MB/min.) Perhaps more important in the TV production environment, however, is the increased transfer speed and LAN capacity that such file-size reductions offer.

Recent developments have heightened the race to be either best or best-priced.

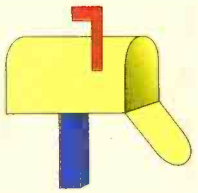
File-based audio transfers between DAWs and other non-linear audio devices are also revolutionizing the distribution of audio outside the facility. Production houses and stations are able to send compressed audio files in non-real-time fashion over analog or digital phone lines or via the Internet and other on-line services.

Multimedia production is having its effect on DAWs as well, with several systems incorporating specific elements for this purpose. These include support of reduced sampling rates and resolutions plus various audio data-compression algorithms for CD-ROM production. A few systems include mastering capabilities for CD and CD-ROM formats.

Finally, as more production moves exclusively to computer-based systems, data backup has become increasingly important. New backup media options and faster backup speeds are an important (and often overlooked) area of current development. More powerful platforms also allow increased use of background operations for backup processes.

All the talk of media convergence notwithstanding, TV production actually seems to be *diverging*, with numerous new venues of distribution arising. The move toward multicasting and multiversioned production argues strongly for a non-linear environment in which DAWs play a key role. The purchase and operating cost-reductions that DAWs offer have also made them attractive, even under purely traditional production scenarios. The digital audio workstation is clearly well-suited for the broadcast facility of today and tomorrow. ■

For more information on digital audio workstations, circle (102) on Reply Card. See also "Recording & Playback Products," p. 58 of the BE Buyers Guide.



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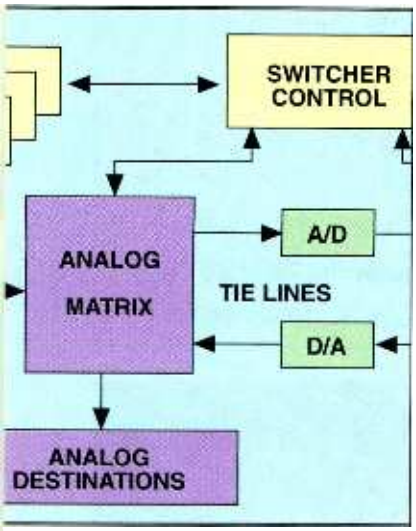


Getting there: Format conversion

By Phil Hejtmanek

The path from origination to delivery can involve many conversions.

The Bottom Line:
As the number of video and audio formats used in the broadcast environment continues to grow, building a flexible facility becomes more difficult. Conversion between formats is possible, but not without significant cost and potential quality loss. Sensible conversion strategies and long-term planning are required to minimize these difficulties. $

In the good old days of TV broadcasting, audio was audio and video was analog composite, period. This meant that interconnection within a broadcasting facility was fairly simple. Subcarrier timing was about the most complex issue that an engineer had to deal with. Unfortunately, those simpler days of yesteryear are gone forever. Advances in technology have forever changed the nature of audio and video equipment, and the emergence of the computer in video production has made digital expertise a must for today's engineers.

Now that the FCC is poised to approve a digital transmission standard for terrestrial TV broadcasting and equipment manufacturers are rolling out new product lines of computer-based digital production equipment, there is pressure on broadcasters to begin the transition from the traditional analog facility to an all-digital environment. Unfortunately, in the real world, the cost of a complete new facility is quite high, and it may not fit into the financial plans of facility owners. There is also considerable uncertainty about the specifics of ATV that makes large investments in technical equipment somewhat risky. The most prudent course for broadcasters today is to follow the trend and build toward digital with a reasonable capital investment, while still getting the most from existing equipment.

Format soup

Although today's engineers seem to be wading ever deeper into a swamp of formats and acronyms, TV broadcasters have had to deal with format changes from the industry's earliest years. For example, the natural output of a color-TV camera has always been an RGB signal, that has to be encoded into the NTSC composite format for transmission to the receiver, where the signal is decoded back to RGB drive signals for the picture tube. Advances in videotape technology have since added numerous analog and digital component formats to the mix. Signal processors, such as DVEs and standards converters that perform spatial manipulation of images, cannot function in the composite domain. These devices inherently contain functional stages that decode incoming composite video into component form and encode the processed components back into composite. A typical TV operation today may have three or more different video formats present, as well as several audio formats. Just being familiar with all the various formats in use in your facility at the moment can be challenging.

More significant format-conversion problems began raising their heads for broadcasters when analog component video equipment became available. The component format's signal-quality advantages over composite were hard to resist, but they did not come without costs in complexity and dollars.

The latest wave in this transition involves some form of component serial digital signal routing. This conversion is likely to make the majority of broadcasters think twice about the economics involved. Unless facility owners are prepared to finance a complete rebuild, most of the existing production equipment, tape machines and graphics hardware will need to be *adapted* to the new digital standard. It is therefore possible that a hybrid system of analog and digital will be present in most broadcast facilities for some time into the future. A TV facility's engineering de-

partment will then be charged with acquiring the proper format conversion devices to make it all work.

Fortunately, broadcast equipment manufacturers have responded with a seemingly endless array of black boxes to handle the job. The trick lies in picking the right tool for the problem at hand, and designing the overall system for maximum functionality at minimum cost.

Finding the building blocks

Many devices are available that transform video and audio signals from one format to another. These products are known variously as encoders, decoders or transcoders depending upon their function. One group of these devices is designed to convert video signals between composite NTSC (or PAL or SECAM) and analog formats offering component I/O, such as Betacam, MII and S-VHS. Some modern TBCs and frame synchronizers on the market also provide simultaneous transcoding functions between these formats.

Many devices are available that transform video and audio signals from one format to another.

On the digital side, there are serializers and deserializers to transform parallel digital formats to serial formats, as well as transcoders that convert composite digital ($4f_{sc}$) to 4:2:2 component digital (CCIR 601) and back. There also are devices to fully transform composite or analog-component recording formats directly to component serial digital (SMPTE 259M) and back. (See "Transition to Digital," March and April 1995.) Finally, there are devices to transform computer video display formats (monochrome, CGA, EGA, VGA, SVGA, XGA) with their various pixel ratios and color resolutions to NTSC composite, component analog or component digital. Prices for these transcoding devices range from a few hundred to several thousands of dollars, depending on the function to be performed. (See Figure 1.)

Note that some signal-quality losses can occur in these format conversions. When simply going from digital to analog, but staying within the component or composite domain, minor degradation from A-to-D and D-to-A conversions can occur, usually resulting from the addition of quantization noise. More significant artifacts are likely when crossing the component/composite boundary in either the analog or digital domains, generally due to changes in bandwidth and the introduction of intermodulation distortion products.

Audio formats also abound in the modern broadcast facility. Converters exist to adapt signals between analog and the AES/EBU serial digital audio formats, as well as others. Sample-rate converters effectively translate between the compact-disc sampling rate (44.1kHz) and that used for most professional digital audio recording devices (48kHz). There are also units to interleave and extract *embedded* digital audio information from a serial digital video bitstream. (See "Transition to Digital," July 1995.) Typical AES/EBU digital encoder/decoder functions have been in-

	ANALOG	DIGITAL
COMPOSITE	NTSC PAL SECAM	$4f_{sc}$ D2 D3
COMPONENT	RGB Betacam M-II Most computer displays	4:2:2 D1 D5 DCT Digital Betacam

Figure 1. Video formats exist in either analog or digital domains and either component and composite modes. This diagram shows today's most popular formats and their respective categories.

tegrated into a small chipset, making it simple for audio equipment manufacturers to offer digital and analog I/O on current hardware.

Some system examples

Many TV stations faced with the digital upgrades required for implementing ATV will find that their current video signal routing systems are in need of expansion. Rather than making a full investment in an all-digital backbone, some station owners have decided to make the transition to digital signal distribution in stages. This decision is heavily influenced by the costs involved in the total replacement of often relatively new analog routers with serial digital systems. Lack of space in the existing facility may also be a contributing factor, making the construction of a totally new routing system difficult without a major upheaval or a move to new quarters.

The transcoding devices needed for transition can approach the cost of the serial digital routing switcher.

Much of the cost of conversion to a fully digital signal routing system comes from the many individual format-converter boxes required to transform existing composite analog, component analog and composite digital devices to SMPTE 259M (serial component digital). In larger established facilities with substantial investment in older hardware, the cost of the transcoding devices needed for a full transition can approach the cost of the serial digital routing switcher itself.

One sensible, long-term transition strategy for coping with this problem is based on the acquisition of an expandable serial digital router frame. This router is initially fitted with enough crosspoints to accommodate just the existing number of signal sources that already use component digital inputs and outputs. This digital matrix is then linked to the existing analog matrix via tie lines and equipped with appropriate transcoders to convert between analog and serial digital. As remaining analog devices in the facility are replaced by new component serial digital units, the digital router frame can be expanded to accommodate the new sources, and a corresponding num-

ber of analog crosspoints can be eliminated. Ideally, the router manufacturer must offer software that can effectively link the two matrices together under a common control system and automatically route signals from one matrix to the other via tie lines using *path-seeking* techniques. Several router manufacturers now offer this capability, but if the router of choice does not offer such features, the same effect can be realized — though less elegantly — through the use of multiple control panels.

Similar arrangements apply to audio-only routing. In many cases, audio routing systems require upgrading due to simple growth and/or the need to manage AES/EBU signals. Often, small stand-alone audio routers also cannot be controlled by external computers. Many digital VTRs and audio-only devices (including DAT machines, audio workstations and signal-transmission codecs for terrestrial and satellite interconnection) that interface with today's routers offer analog and AES/EBU I/O, so the external format-conversion boxes often needed for video signals are not generally required.

One other important point applies to the cost analysis for audio-only switcher replacement. Because two analog audio channels are multiplexed together in a single AES/EBU digital stream, only one AES/EBU audio matrix is necessary, rather than

An analog-to-digital format conversion process can involve a number of hidden problems.

two matrices for analog stereo. Multichannel audio environments maintain this 2-for-1 arrangement, with every two audio channels requiring only one AES/EBU switcher matrix or level. The cost savings that this provides, combined with the corresponding savings in cable and connectors, can often pay for the additional encoders and decoders needed to interface any remaining analog-only devices still in use at the facility. (These audio conversion devices are relatively low-priced.) In the future, new digital devices can be added to such a hybrid system, while the older analog-only sources continue to be supported. Some analog distribution will likely be maintained at many facilities for monitoring, news/field operations and other utility uses.

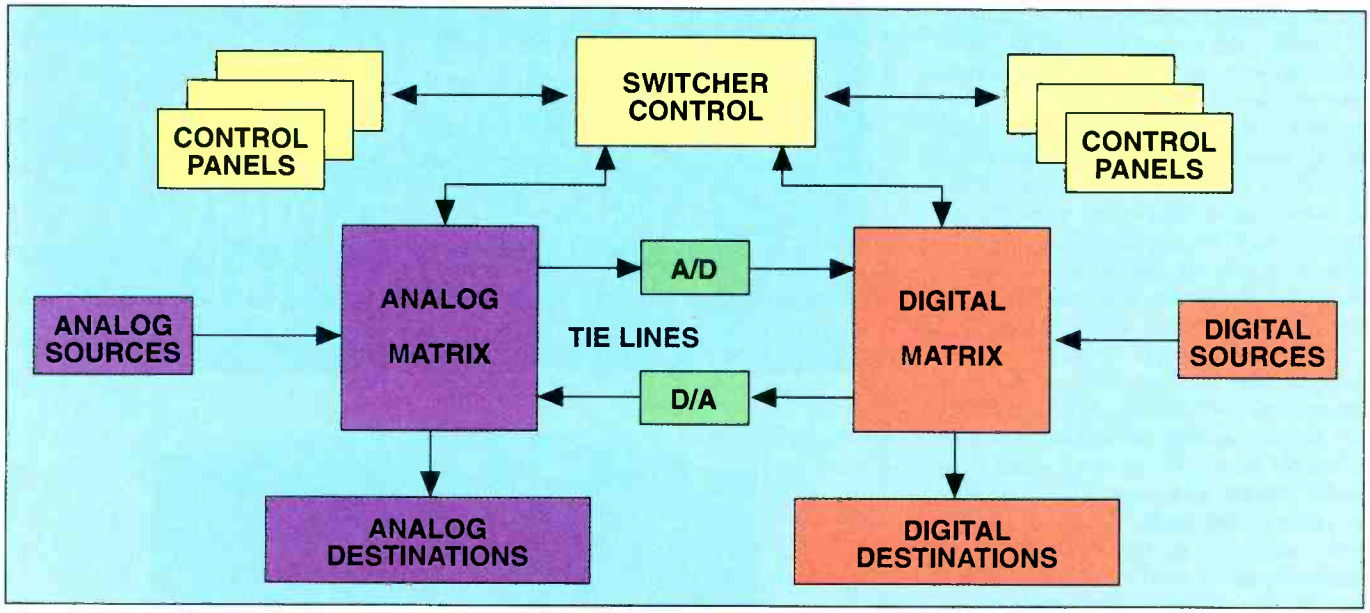


Figure 2. A conceptual block diagram of a hybrid analog/digital routing environment. As the transition to digital progresses, the size of the analog matrix will decrease and the size of the digital matrix will increase. The number of tie lines and converters can also be reduced over time.

Caveat emptor

An analog-to-digital format conversion process can involve a number of hidden problems that will add to its challenges. For example, mixing digital and analog video can result in huge timing differences, due to the relatively long delays associated with digital encoders and decoders. Delay values of 70µs or more can appear, which are orders of magnitude greater than those delays compensated for with timed cable lengths in analog-only sys-

tems. Therefore, the cost of digital frame synchronizers must be factored into the total price of conversion. There are also rather severe limitations on cable lengths for serial digital video between reclocking distribution amplifiers.

Routing AES/EBU signals along with low-level analog audio can cause crosstalk, so this should be avoided.

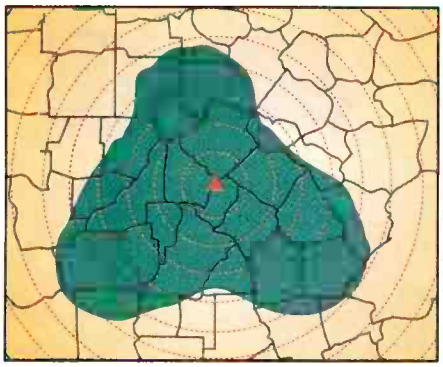
On the audio side, routing AES/EBU signals along with low-level analog audio can cause crosstalk, so this should be avoided. There are also cable-length restraints associated with AES/EBU signals, and audio test-monitoring and troubleshooting can no longer be done with a headphone and clip leads.

The transition between analog and digital formats is something that all broadcast engineers will be facing in the future. Ultimately, TV engineers may be converting their existing NTSC facilities to simultaneously feed both an analog NTSC transmitter and a component digital HDTV transmitter. Simultaneous full-time feeds from multiple sources and to multiple outputs may also have to be handled. A full understanding of the formats themselves and the tools available to make the required transitions will be critical to the technical and economic success of these upcoming projects. ■

Phil Hejtmanek is director of technology for the Southern Illinois University Broadcasting Service(WSIU-FM/TV and WUSI-FM/TV), Carbondale, IL.

For more information on format conversion, circle (101) on Reply Card. See also "Signal Conversion Equipment," "Encoders, Decoders" and "Format Translators," pp. 75-81 of the BE Buyers Guide.

By John Crooks



Tower maintenance secrets revealed, part 1

Tower maintenance is a phrase that is widely used and largely undefined. Yet, tower maintenance is a crucial part of every operating system that helps to assure continued operating performance. A well-conceived plan for tower maintenance is critical for all tower sites.

A tower is part of an operating system that encompasses the tower, antennas, transmission lines, radio equipment, shelter, and the site itself (road, compound, fencing, etc.). Several parts of the system require special maintenance beyond the scope of these articles. "Tower maintenance," as defined here, relates to the tower structure, the shelter and related attachments.

Governing agencies

FAA — Requires lighting and painting on towers over 200 feet.

EIA — Suggests maintenance criteria and intervals for towers.

OSHA — Requires fall protection for workers. Also sets forth specific limits for worker exposure to RF during tower maintenance.

Tower maintenance is the act of "keeping up" a tower or "maintaining" it as close as possible to its original intended design and/or purpose. This is necessary and desirable for several reasons:

- Continued good performance of the system and the structure itself.
- Safety and health of workers and employees that must work on or under the structure.
- Safety of aircraft that must fly near the site.
- To fulfill regulations imposed by governing agencies.

Several governing bodies have a vested interest in the proper and timely maintenance of towers. There are four main agencies that affect the area of tower maintenance. They are:

- Federal Aviation Administration (FAA) — governs painting and lighting requirements.
- Federal Communications Commission (FCC) — the enforcement arm for FAA.
- Electronics Industries Association (EIA) — recommends design and maintenance criteria.
- Occupational Safety and Health Administration (OSHA) — governs worker safety.

There may also be other local or private agencies that have a vested interest in how your specific tower is maintained. For example, your insurance company may require periodic inspections or special points of inspection.

The maintenance plan

The first step in managing anything, including tower maintenance, is planning. A plan must be well-conceived and outlined to be effective. Develop a list of items that you would like to have maintained while the inspection proceeds.

For example, during the inspection, the crew finds some loose tower bolts. Would you have the crew tighten the bolts while on site? This may sound like an almost absurd question. However, it is a question that comes up often and can lead to a great deal of investment. If there are two bolts loose, it would be a minor problem. If there happen to be a hundred or so bolts loose, this could mean several crew days to repair. Would your inspecting company need to figure this into their bid, or look for additional funding over the original inspection cost?

EIA specifications

Guy tensions: Must be within manufacturer's specifications for tension, based on temperature, within +/-10%.

Tower plumb: 1 in 400 for overall tower height or between any two guy points. This can also be translated as 0.0025 times the distance in question.

There are several areas where this question might come up over the course of an inspection:

- *Tower lighting and marking:* Tower lighting and marking is an item dear to the heart of the FAA. Current FAA regulations state that a tower owner has 30 minutes to report a non-compliance condition and 15 days to correct the condition if it pertains to a tower's main lighting system. Penalties can be large for non-compliance, so immediate attention should be given to these items.

- *Tower alignment and/or tension:* When tower alignment or guy wire tensions are found to be outside of EIA specifications, immediate attention is required. EIA specifications are lenient in comparison to many customers' specifications. When EIA specifications are not met, this can mean trouble for the structural integrity and longevity of the tower.

Originally an AM tower, the structure was converted to a paging/2-way tower. All of the new antennas were located at the top of the tower. The tower was not designed for the increased windload and eventual collapse of the tower occurred.

How to plan now for tomorrow's digital facility.

Now is the time to begin the conversion process. It's no "plug and play" endeavor. Proper technical planning is vital today to prepare stations and post facilities for the future in digital.

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Produced by Intertec Presentations, a division of Intertec Publishing

Contractor qualifications

- Request information from at least six companies.
- Obtain prior experience and reference information.
- Take into consideration mobilization costs when choosing a contractor.
- Obtain bids from at least three contractors.

• *Grounding:* Proper grounding is crucial for continued system performance. Any major grounding problems should be handled at the time of inspection. Broken ground wires at the tower base or transmission line grounding should be repaired immediately.

• *Shelter environment:* An inspection should include an overview of the shelter. If air-conditioning is required for equipment cooling, an inspection would reveal an inoperable system. Remedy should be given to the situation immediately.

• *Corrosion protection on tower:* This may not be a critical item unless deterioration has progressed to the point of damaging tower members. However, it could be quite cost-effective to have the crew make minor finish repairs to the tower. This would include wire brushing, cold galvanizing and topcoating.

Each of these items should be planned for well in advance of implementation. They must also be communicated with the inspection crew at the time of proposal. In addition to this list, an inspection format must be developed. This will include inspection procedures and a list of items to be inspected. (This will be explored in part 2 of this article.)

Develop a standard for intervals of inspection. EIA recommends that guyed towers be inspected every three years and that self-supporting towers be inspected at 5-year intervals. Again, this is lenient, in comparison to many owner requirements. Some owners require that their towers be inspected on a yearly basis.

Much of the discrepancy between the intervals lies in the reason behind the inspections. There is little chance of the structure having major problems between 3-year inspections without outside forces acting upon it. However, the performance of the equipment on the tower can be materially changed by normal conditions. Example: weatherproofing can deteriorate over a 3-year period, possibly allowing water to enter the lines.

As our recommendation, all tower structures ought to be inspected at intervals no longer than three years. More stringent intervals should be followed where equipment concerns are paramount and where outside forces act unusually upon the structure. (For example, inspection after a large wind storm.)

Towers should be maintained at regular intervals no less stringent than the tower inspections. Some items will need maintenance at more frequent intervals, such as yearly antenna system sweeps, and repairs will need to be made between regularly scheduled maintenance times as required. Cost savings can be realized by having the inspecting crew perform simple maintenance items while already at the site. As a minimum, there will be cost savings from mobilization.

As managers, we deal regularly with three criteria in our projects: time frames, budgets and quality standards. Internally in a corporation, a system must be implemented to assure that tower inspections must be completed at pre-determined intervals, according to specified procedures and according to a realistic budget.

Assuming that the inspection work will be done with outside sources, there is some homework that must be done. Contractors must be screened carefully and all necessary information regarding inspection requirements must be clearly communicated.

Bidding documents should include the following information:

• Clearly state the final objectives of the maintenance/inspection effort.
• Include a full technical requirement outline. For example, a specific form that must be filled out or a specific procedure for measuring guy wire tensions, etc.
• Ask for bids that would offer a certain scale of economies. For example, awarding multiple sites to one contractor may generate savings in mobilization expenses.

Tower maintenance is a critical item to help assure continued system performance. Planning is a key starting point to the tower maintenance. Part 2 of this article will investigate specific areas that should be inspected on tower systems. ■

John Crooks is the vice president, and instructor at the tower technology school, for Broadcast Communications, New Glarus, WI.

E-mail:
be@intertec.com

CompuServe:
74672,3124

FAXback:
913-967-1905

INDUSTRY BRIEFS

BUSINESS

TimeLine Vista Inc., Vista, CA, has formed an alliance with Computer Concepts, Inc., Lenexa, KS. Under the terms of the agreement, Computer Concepts will market a radio production and post-production version of TimeLine's DAW-80.

BTS Broadcast Television Systems, Simi Valley, CA, has announced the sale of its Media Pool video server to KGO-TV, the Capital Cities/ABC Network-owned TV station serving San Francisco and northern California, for its new all-digital studio.

Abekas, Redwood City, CA, has installed its 8100 switcher, a pair of A57 DVEs and the new Diskus digital disk recorder in Videosmith's post-production facility, Philadelphia.

Pixel Power Inc., United Kingdom, has announced the 100th purchase of its Collage generator and graphics system by The BBC at Elstree, UK.

Telex Communications, Inc., Minneapolis, and NBC have reached an agreement for Telex to supply several RTS intercom systems to NBC during the next year.

Sony Corporation, United Kingdom and Oracle Corporation, Redwood Shores, CA, have signed a letter of intent to work together to develop video, audio and text news database products. The companies' goal is to increase broadcast newsroom productivity by combining video and audio clips with wire service text on a single edit workstation.

Tektronix, Beaverton, OR, and Lightworks Editing Systems have closed the transaction for Tektronix to acquire Lightworks.

Graham-Patten Systems, Grass Valley, CA, has supplied Editel-LA, Hollywood, CA, with three D/ESAM 400 digital edit suite audio mixers for use with a trio of recently completed telecine suites equipped with Rank Ursa systems with Renaissance DaVinci color correction and Alpha Image Alphie component switchers.

Itelco, Orvieto, Italy, has opened its second office in the United States. The new office is located in Denver, and will serve North America, including Canada. The phone number for the Denver office is 303-431-1699; fax 303-431-2868.

PEOPLE

Al Jensen has been named marketing communications manager for BTS, Simi Valley, CA.

David E. Acker has been appointed vice president of engineering for Nova Systems, Canton, CT.

Dean Winkler has been named president of Post Perfect, New York, NY.

Kevin Dauphinee has been appointed product marketing director for the Digital Video Storage Systems business unit of Tektronix, Beaverton, OR.

David Gardner has been named director of media services for the Satellite Services organization of Orion Atlantic, Rockville, MD. Also, Arthur Hill has been named executive director of satellite services sales.

Chris Emery has rejoined Sony, Park Ridge, NJ, as director of marketing for professional media.

Michael Wellesley-Wesley has been elected to the board of directors at Chyron Corporation, New York, NY. ■

NEW PRODUCTS

Audio/video delay
Prime Image

• A/V delay: a self-contained, solid-state unit that delays both video and audio for up to 30 seconds (standard configuration is shipped with just over 10 seconds of delay) without data compression and switches in alternative audio and/or video feeds as required; either audio or video — or both — signals can be replaced, recorded or rerouted as necessary within the unit; video input and output are composite, Y/C, Y/U/V, or Y/R/B, and the unit is fully compatible with component signals.

Circle (350) on Reply Card

Miniature HMI light
Frezzolini Electronics

• Day-Arc light: a miniature HMI, high-output daylight temperature light in a single self-contained unit; the Day-Arc provides daylight temperature light (5,500°K) by drawing only 24W of power and outputting the equivalent of a 100W quartz bulb; with a single Frezzi NP battery, the Day-Arc will provide the equivalent of 100W of light for an hour; the operating life is over 500 hours.

Circle (358) on Reply Card

MOD-based digital video recorder
Rorke Data/ Future Equipment Design

• Video MOD 100: a magneto-optical drive (MOD)-based standalone fully featured digital video recorder; the Video MOD 100 replaces all analog VTRs from VHS to Betacam and is capable of CCIR 601 component digital video output and full serial remote control; two channels of selectable 8/16 bit digital audio are provided for original or master audio applications with full insert edit functions; all functions are accessible from the front panel.

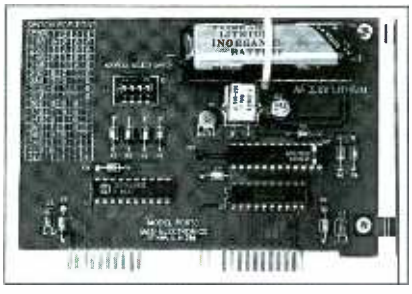
Circle (351) on Reply Card

Edit controller
Editing Technologies Corporation (ETC)

• Stiletto: an edit controller that features a graphical user interface screen and includes all the necessary hardware and software for control of VTRs, switchers and other devices; available as a 2- or 3-machine package that includes two general-purpose interfaces; the open architecture allows for multilinear and nonlinear editing compatibility; a complete Aladdin software package is included with the software to run most popular production switchers; the Stiletto supports Sony, Panasonic, JVC and BTS 9-pin serial protocols.

Circle (352) on Reply Card

Stable real-time clock for PCs
B&B Electronics Manufacturing Company



• Model PCRTC: an accurate, temperature-stable, real-time clock for PCs; the clock is based on a highly stable oscillator circuit and uses a software driver to update the DOS clock every minute; the 8-bit (short slot) PCRTC card does not require IRQ lines and reduces the computer's clock error to 15 seconds/month; when the power is off, a 3.6V lithium battery maintains the clock and a battery function status allows the battery to be replaced before the time is corrupted.

Circle (354) on Reply Card

Integrated computer interface
Varian Associates Inc.

• F series integrated computer interface: Varian's 400W to 700W F series satellite communications (SATCOM) uplink amplifiers now include an integrated computer interface and standard pin diode attenuator (optional integral linearizer available); the interface allows direct communications with the user's PC/digital interface for monitoring and control without taking up valuable rack space with the placement of an external controller; the interface is designed to work with all current F series amplifiers and all SATCOM frequencies.

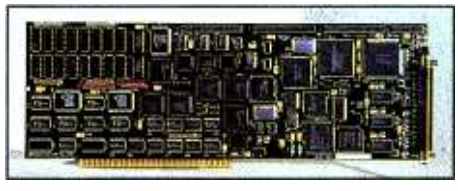
Circle (355) on Reply Card

Rotator
TIC General, Inc.

• Ringrotor: rotator that allows antennas and dishes to be mounted at any safe mounting location on a tower and rotated around the tower 360 degrees in either direction; a rugged steel mounting ring encircles the tower and the Ringrotor rides on a drive bracket assembly that allows the ring to rotate around the tower; features a 24-VDC gear motor; RS-232 interface and/or remote port also available.

Circle (356) on Reply Card

Non-linear editing system
Applied Magic



• Broadcaster Elite: an Amiga-based non-linear video editing system designed to enhance the video editor's ability to compose images and sound; the system is capable of sustaining transfer rates equivalent to the fastest SCSI II hard drives on the market; the Elite works in composite, Y/C or Betacam SP formats; to work in the component domain, the Elite uses three on-board digitizers for Betacam SP, one for each component of Y, Cr and Cb.

Circle (353) on Reply Card

PROFESSIONAL SERVICES

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FOR SALE

EDUCATIONAL TRAINING

EQUIPMENT WANTED

WANTED: USED VIDEO EQUIPMENT Systems or components. PRO VIDEO & FILM EQUIPMENT GROUP: the largest USED equipment dealer in the U.S.A. (214)869-0011.

WANTED: For RCA TM-21 color monitor flyback #214870 and power transformer #213987 or entire monitor. J. Ballard (212) 664-3033.

EQUIPMENT FOR SALE

FOR SALE: ABEKAS A-42 STILL STORE 2 Channels, Excellent Condition, 1 Year old. Used 50 hours. $16,500. Call Bob 919-772-8347

FOR RENT

SUB CARRIER availability now offered on a 100KW FM clear channel in the Dallas Fort Worth area. Please call (214) 716-7829.

TRAINING

FCC GENERAL CLASS LICENSE. Cassette recorded lessons for home study. Our 30th year preparing radio technicians for the license. Bob Johnson Telecommunications. Phone (310) 379-4461.

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POSITION WANTED

ENGINEER WITH 19 YEARS EXPERIENCE in post, broadcast, dealer support, engineering management, system design and installation. Factory trained D1, D2, digital betacam, 1" switchers, editors, cart, studio/ENG cameras, etc, etc. Seeks stable long term engineering opportunity. Prefer Chief/Asst. Chief in Florida marketplace. Willing to relocate. For more information send inquiries to Classified Ad Coordinator, Broadcast Engineering, Dept. 766, 9800 Metcalf, Overland Park, KS 66212-2215.

HELP WANTED

MAINTENANCE ENGINEER: Immediate opening for Maintenance Engineer. Associate Degree in Electronics and 4-6 years experience TV Maintenance. FCC General Class license required–SBE certification desirable. Individual must be energetic, self-starter with experience in component level troubleshooting and maintenance of a wide variety audio, video and RF equipment. U-Matic maintenance experience required, Beta experience a plus. Must also share in driving/operating KU band SNG truck (chauffeurs license required). Some weekends and nights required, and occasional master control operating shift. Minorities and women encouraged to apply. Send resume listing references, salary requirements and any manufactures technical schools to: Chief Engineer, KOMU-TV, 5550 Hwy. 63 South, Columbia, MO 65201. An EEO, Affirmative Action Employer.

VIDEO PROJECTIONIST- National staging company seeking independent contractors on a project by project basis. Qualifications include a working knowledge of Sony 1270 video projectors interfaced with various computer systems, both doubled and tripled stacked. Familiarity with Barco 8100 or GE light valves a plus. Must be able to deal effectively with client and crew. Place of residence not a factor. Travel required. Send resume and references to Classified Ad Coordinator, Broadcast Engineering, Dept. 764, 9800 Metcalf, Overland Park, KS 66212-2215.

COMPUTER/VIDEO TECHNICIAN Experience with mini computer hardware, software networking and related systems. Ability to understand and maintain various analog and digital control systems. Basic knowledge and willingness to learn high-end video and audio systems is a plus. Capable of being "on-call" for systems problems. Send resume to: Engineering Manager, P.O. Box 4800, Baltimore, MD 21211. (June issue correction: P.O. Box 4798 is incorrect.) Equal Opportunity Employer.

MASTER CONTROL OPERATORS wanted to oversee playback operations for major cable channels, New York City based. Fax resumes to (212) 941-1821. No phone calls please.

HELP WANTED

SYSTEMS DESIGN ENGINEERS
SENIOR PROJECT MANAGERS

As a result of continuing growth, AFA is expanding its Project Engineering staff.

A.F. Associates is an acknowledged leader in the design, engineering and fabrication of advanced television systems and facilities for the industry's most prestigious clients.

We are seeking talented and experienced systems engineers to join our dedicated staff of professionals and become involved in a number of very visible and challenging projects.

AFA offers a dynamic, yet "small company" work environment, located in suburban Northern New Jersey. As a subsidiary of Video Services Corporation, we offer unique growth potential in the industry's fastest growing group of high-tech companies, as well as a comprehensive package of benefits.

Candidates should have a minimum of five years of broadcast systems design experience, characterized by the proven ability to perform detailed design of digital video and audio systems. Fluency in AutoCAD is a must. You must be well-versed in breaking technologies, including computer-related video disciplines such as video file servers, and demonstrate the ability to manage an intricate project where the client's satisfaction is the highest priority.

An EE degree or significant industry experience is required.

Please send resume' and salary history to:

Mr. Jim McGrath ~ Vice President of Engineering

No phone calls, please.

AFA

A.F. ASSOCIATES, INC.
100 Stonehurst Court, Northvale, New Jersey 07647
FAX 201-784-8637

A Video Services Corporation Company - AFA is an Equal Opportunity Employer

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CHIEF ENGINEER - Dominant gulf coast affiliate seeks a chief engineer who can lead us into the digital future. The successful candidate will have excellent technical and leadership skills plus a thorough knowledge of broadcast equipment including RF transmission systems. Requirements are an FCC license, college or technical degree (or equivalent experience), plus at least 10 years broadcast engineering experience. Send letter, resume, references and salary requirements to Veronica Bilbo, EEO Coordinator, KPLC-TV, P.O. Box 1490, Lake Charles, LA 70602. EOE.

BROADCAST MAINTENANCE ENGINEER to maintain television broadcasting equipment for a large college radio-TV-film department in the Los Angeles area. Requires formal education in electronics and 2 years technical engineering work in a television broadcasting environment. Salary: $49,120. Excellent benefit package. Call for application: (213) 891-2129. LOS ANGELES COMMUNITY COLLEGE DISTRICT. Deadline: August 25th. AA/EEO.

CHIEF TV ENGINEER Immediate opening. Large college radio-TV-film department in the Los Angeles area. Requires formal education in electronics and 5 years experience maintaining a wide variety of commercial color television equipment, including 2 years maintaining commercial broadcast quality color television systems. Salary: $54,992. Excellent benefit package. Call for application: (213) 891-2129. LOS ANGELES COMMUNITY COLLEGE DISTRICT. Deadline: August 25th. AA/EEO.

ATLANTA CHIEF ENGINEER Trinity Broadcasting station in the Atlanta area. Experienced in maintenance of UHF transmitter, studio systems as well as personnel supervision and training. SBE certification a plus. Send resumes to Ben Miller, Mail P.O. Box C-11949, Santa Ana, CA 92711; E-mail: BMILLER614@AOL.COM; Fax: 714/665-2101. M/F EOE.

MAINTENANCE ENGINEER Black Entertainment Television Inc. Ability to troubleshoot to the component level production switchers, digital video effects systems, routing switchers, vtr's character generators, cameras, editing systems and audio equipment. This will include system interfacing to computers and compatible components, equipment installation for studio and remote productions. Must be knowledgeable of system timing theory, broadcast specifications, and electronics course study. Ability to perform fiber switches and satellite downlink. Must have 3 years experience. BET, Corporate Human Resources, 1905-E 9th Street, N.E., Washington, D.C. 20018

TELEVISION HELP WANTED, TECHNICAL Assistant Chief Engineer: Looking for well qualified Assistant CE who can eventually assume position of CE for UHF station. FCC general class license; SBE certified. Send detailed resume and salary requirements to Classified Ad Coordinator, Broadcast Engineering, Dept. 765, 9800 Metcalf, Overland Park, KS 66212-2215. EOE.

VIDEO ENGINEER- National staging company seeking independent contractors on a project by project basis. Qualifications include a working knowledge of component systems with multiple routers in a live environment. Responsibilities include set-up, operation and troubleshooting of component packages, videotape machines, cameras, routers, and interfacing various computer systems. Must be able to deal effectively with clients and crew. Place of residence not a factor. Travel required. Send resume and references to Classified Ad Coordinator, Broadcast Engineering, Dept. 763, 9800 Metcalf, Overland Park, KS 66212-2215.

TRI-STATE CHRISTIAN TV has trainee positions open in production and engineering. Some experience helpful. Must be willing to relocate. Send resume to P.O. Box 1010; Marion, Illinois 62959. An EEO employer.

HELP WANTED

Video Service/Maintenance Technician

Swiderski Electronics, Inc. a leader in the Audio/Video/Telecommunications field, has an immediate opening for a qualified Audio/Video Service/Maintenance Technician. 2 yrs. exp. Position works with Broadcast/Industrial 1/2', 3/4' and 1' VTR's & related equipt.

Send resume & salary history to:
H/R Dept., 1200 Greenleaf Ave.
Elk Grove Village, IL 60007
Fax resume (708) 364-5019

STATION MANAGER

with television engineering background needed immediately for KSKN-TV in Spokane, Washington. Individual responsible to operating full power, 24-hour, UHF home shopping network station. Must be experienced in transmitter, studio, and microwave maintenance. Knowledge of FCC regulations and compliance mandatory. Management experience a plus but not required. Good people and community relations skills necessary. FCC license required. Send resume to KSKN-TV, Inc., Corporate Office, 408 Paseo Companeros, Chico, CA 95928. KSKN-TV is an equal opportunity employer.

Television Maintenance Engineer/Television Engineer: State of the art television and radio broadcast facility with satellite uplink is accepting applications for the following positions: **Television Maintenance Engineer-Three to five years experience** in the installation and maintenance of television and radio production/broadcast equipment. Experience in RF troubleshooting, performance measurements for television, radio and satellite systems required. FCC license and/or SBE certification with two year degree required, four year degree preferred. Ability to design systems and circuits. Knowledge of computer operating systems. Ability to work under pressure and willingness to work any shift, weekends, holidays and overtime. **Television Engineer II-**One year minimum of experience in RF troubleshooting, operation and maintenance of television and radio production/broadcast equipment. FCC license and/or SBE certification with two year degree required, four year degree preferred. Knowledge of computer operating systems. Knowledge of FCC rules and industry standards. Ability to work under pressure. Willingness to work any shift, weekend, holidays and overtime. Apply at Human Resources, Grand Valley State University, 158 AuSable Hall, Allendale, MI 49401. Deadline date is August 31, 1995. EEO/AA/ADA.

CLASSIFIED ADVERTISING RATES

Advertising rates in **Broadcast Engineering** Classified Section are $119.00 per column inch, per insertion, with frequency discounts available. There is a one inch minimum and ten inches maximum.

Ads may also be purchased By-The-Word for $1.75 per word, per insertion. Initials and abbreviations count as full words. Minimum charge is $40 per insertion.

Blind box ads (replies sent to **Broadcast Engineering** for forwarding) are an additional $40.00. Reader Service Numbers are available for $50.00 per insertion. Ads four inches or larger receive a Reader Service Number free.

Spot color, determined by **Broadcast Engineering**, is available at $95.00 per insertion.

No agency discounts are allowed for classified advertising.

Call Matt Tusken
Classified Sales Manager
at 800-896-9939
to reserve your classified ad!

CNN

TELEVISION ENGINEERS

Turner Broadcasting System, the leading News, Sports, and Entertainment system in satellite communications, has career opportunities for engineers with **broadcast maintenance** experience. These positions demand an extensive background in television engineering and at least two years of training in electronics technology. Turner Broadcasting System offers an excellent benefit and compensation program.

Send resumes to:
Mr. Jim Brown, Corp. Engineering
Turner Broadcasting System, Inc.
One CNN Center
P.O. Box 105366
Atlanta, GA 30348-5366
(404) 827-1638 office
(404) 827-1835 fax

TBS is an equal opportunity employer

RF/TRANSMISSION TECHNICIANS
Full Time-Floral Park, NY

Rainbow Network Communications, an established satellite up-link and transmission center, is seeking experienced AND entry level Technicians:

EXPERIENCED: Extensive background with microwave frequency equipment, ability to install/maintain up and downlink facilities and a thorough knowledge of video/audio transmission required; fiber optics experience and ability to troubleshoot at component level preferred.

ENTRY LEVEL: A basic knowledge of satellite communications and video/audio transmission concepts required.

All positions require the ability to work under pressure, strong communications skills and availability for flexible schedules (weekends, nights, holidays). A technical or college degree is preferred.

Please send resume and salary history/requirements to: PO Box 999-RF2, Woodbury, NY 11797. An equal opportunity employer.

TELEVISION CHIEF ENGINEER POSITIONS (2):

Group operator has two Chief Engineering openings. Both in small, second-hundred markets. These are hands-on, maintenance-intensive positions that offer the opportunity to develop management and people skills. Positions are in northern California and southwestern Texas.

The stations are being acquired by a new owner with substantial major market experience. The successful candidates will be joining a new team of broadcast professionals and play a key role in developing the stations into strong, professionally-managed competitors in their markets.

If you have excellent studio/transmitter maintenance skills and want the challenge and responsibility of managing and maintaining the technical operations of a small-market television station, please send your resume to Bachow & Associates, Inc., 3 Bala Plaza East, Suite 502, Bala Cynwyd, PA 19004 c/o Mr. Fisher or fax to 610/660-4930.

WE PLACE

(Technical Engineers-Post Production Editors, Colorists, Graphics & Animators)

• All Levels, Locations, & Disciplines •

Employer Paid Fees
Guaranteed Confidential
15 Years Service

FAX and/or Mail your Resume to Mike Kelly

KEYSTONE INT'L, INC.
16 Laflin Road, Suite 900
Pittston, PA 18640

Fax 717-654-5765 • Phone 717-655-7143

CHIEF ENGINEER:

NY 1 News, a technological leader in local news, has a challenging position for a Chief Engineer who will play a key role in moving NY 1 into a digital future. You should be self-motivated, organized and have:

- Experience in news operations
- Strong management and budgetary experience
- Working knowledge of LMS and automated playback systems
- Experience with all tape formats, especially Hi 8
- Strong maintenance, troubleshooting and system design skills
- Knowledge of server based/digital production systems

Please send or fax your resume and salary history to:

Harlan Neugeboren
Director of Operations & Engineering
NY 1 News
460 West 42nd Street
New York, NY 10036
FAX (212) 563-7156

NY 1 NEWS

NY 1 IS AN EQUAL OPPORTUNITY EMPLOYER

13 MTN

The Manitoba Television Network has an immediate opening for a Chief Engineer based at its studio facilities in Portage la Prairie. The ideal candidate should have strong hands-on technical expertise and a minimum of 5 years experience along with strong managerial skills. You will be part of an innovative independent station and work with a team of people dedicated to quality.

If you enjoy the challenge of a major market television operation with the benefit of small community living, this challenging opportunity could be for you.

Submit resumes in confidence to:
Mr. Drew Craig
General Manager
Manitoba Television Network
P.O. Box 13000
Portage la Prairie MB R1N3V3

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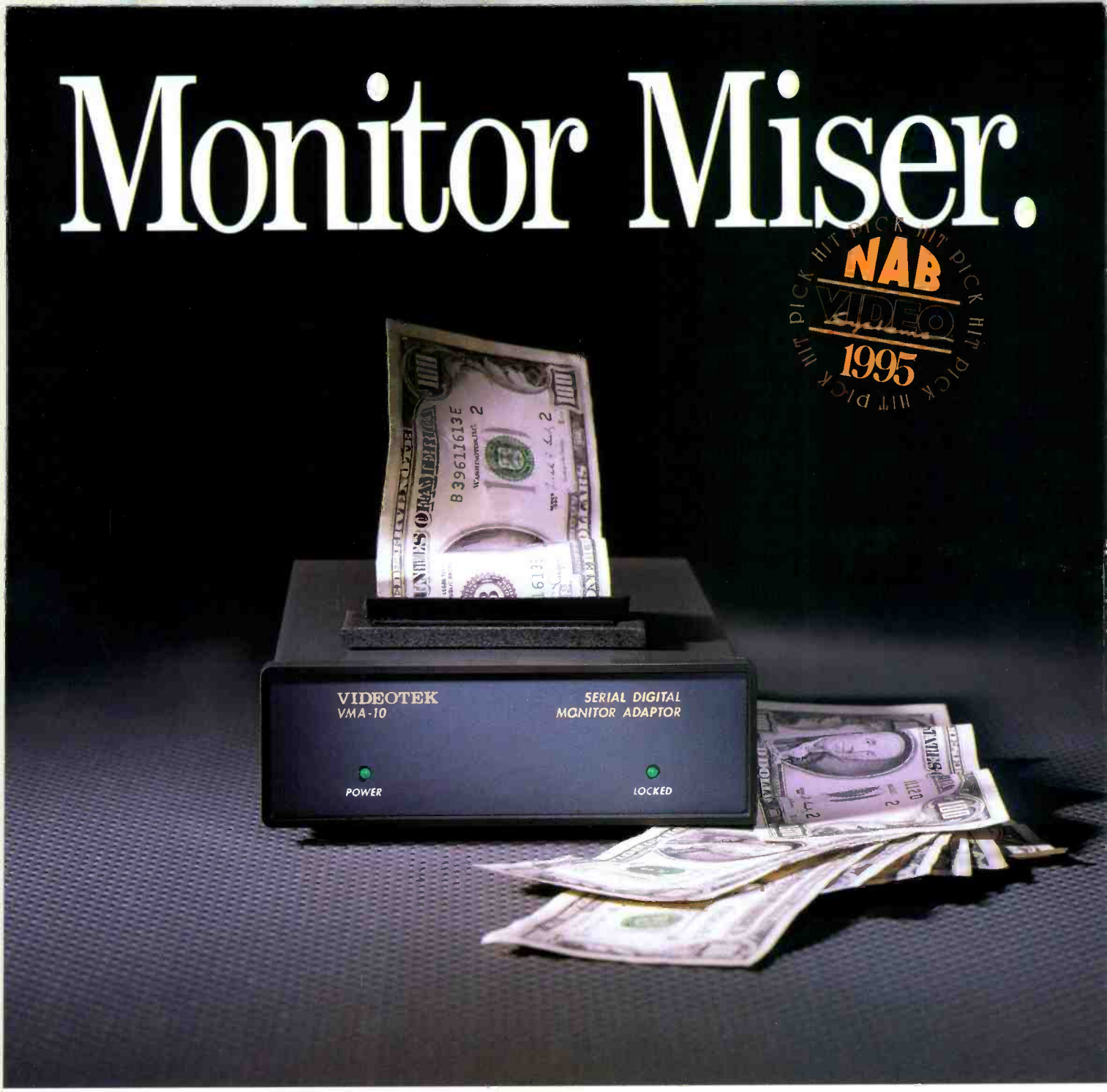

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