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JANUARY 2004

Broadcast Engineering®

THE JOURNAL OF DIGITAL TELEVISION

Remote trucks

Business issues drive technical decisions

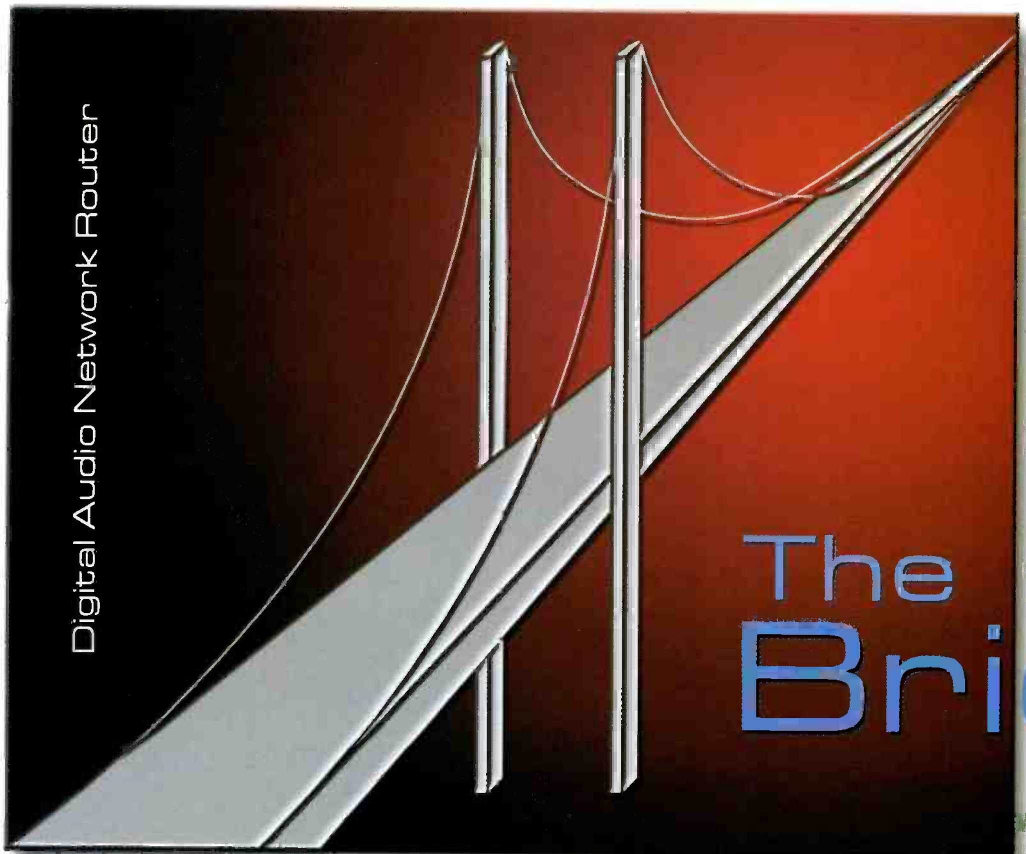
Special report: Multichannel broadcasting

Is it the "killer app"?

Download: 50 years of progress

How far we've come

A PRIMEDIA PUBLICATION



The Bridge

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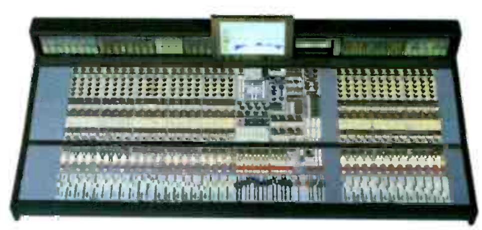

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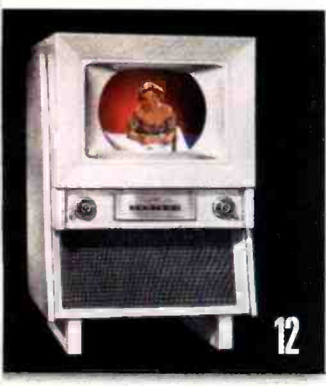
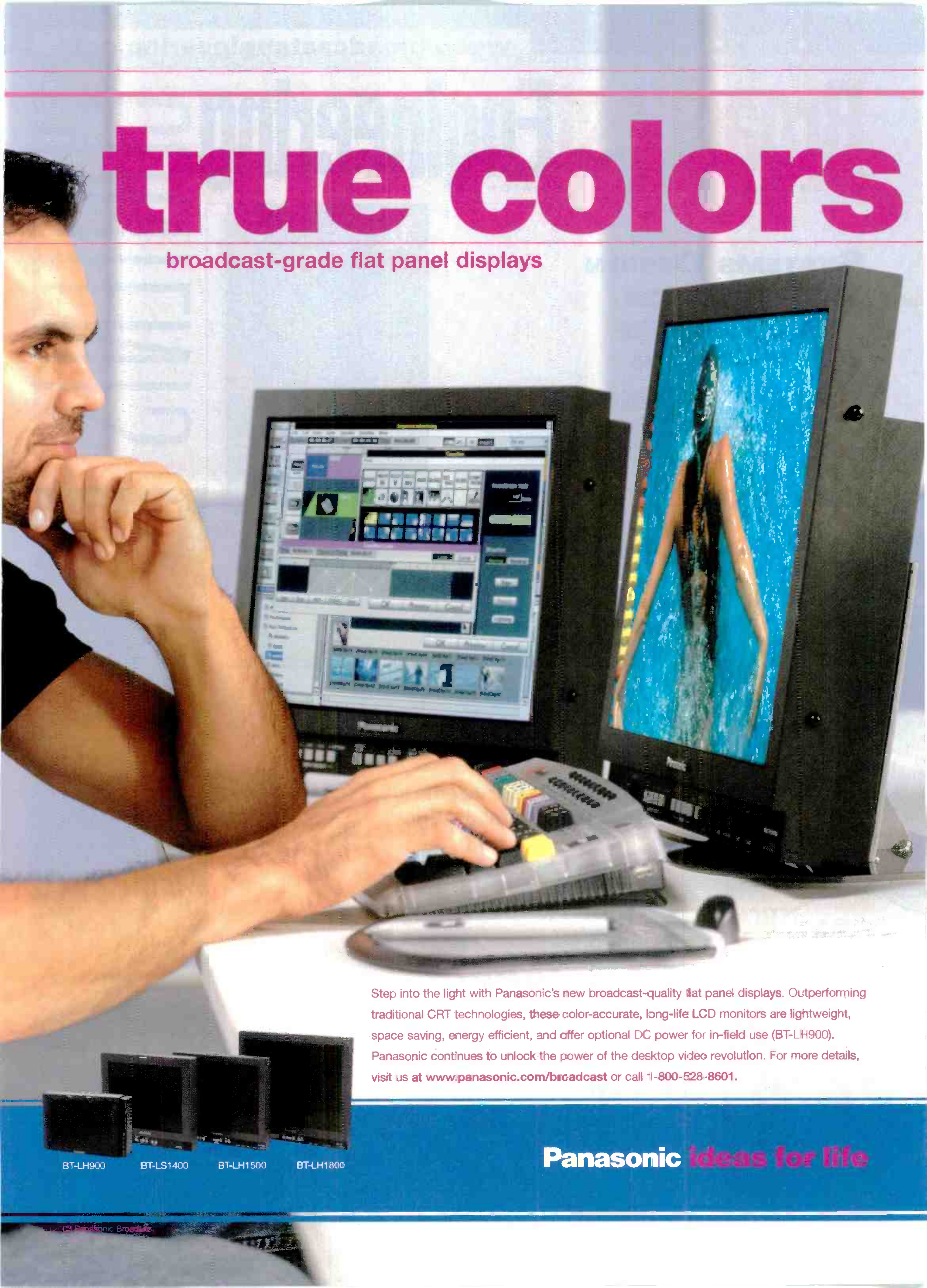
DIGITAL HANDBOOK



ON THE COVER: Miles of audio and video cable all carefully labeled and bundled into racks and then connected to equipment form the backbone of today's digital remote broadcast trucks. Photo courtesy Bennett Systems.

(continued on page 6)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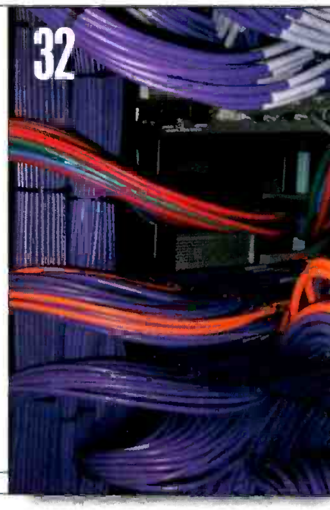

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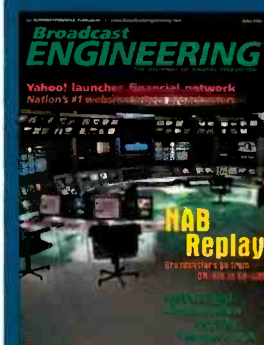
Name this VTR



What was unique about the NEC SR-10 recorder? Correct entries will be eligible to win a *Broadcast Engineering* T-shirt. Enter by e-mail. Title your entry "Freezeframe-January" in the subject field and send it to: bdick@primediabusiness.com. Correct answers must be received by March 17, 2004, to be eligible.

Is HD
a subscription service?

High-definition images will save over-the-air broadcasting. Right? Not so fast, TV breath. It seems that viewers are so confused about HD that almost half don't know if HD programming is available in their area and 23 percent don't even know if they have an HDTV set!

A recent study by Dove Consulting provides a conflicting image of viewers' perceptions of HD programming and technology. The study, which was based on

1500 consumers, was finished in November 2003.

More than 87 percent said they had some awareness of HDTV. That's up from 81 percent in April 2003. Also, there's an increased willingness among viewers to pay a premium for an HDTV set. About 10 percent of those surveyed said they would pay $1500 for an HDTV set. This rate doubles to 20 percent if the set costs $1000, and almost one-third said they'd buy an HD set if it cost $700.

When it comes to HD programming awareness, it's clear that both broadcasters and the consumer electronics industry have again failed to educate the public. Of the less than half that do know that HD programming is available in their area, 56 percent learned about it from some form of advertising. Cable is the most effective at marketing HD, with almost 33 percent of viewers learning about HD programming from their local cable provider. Only 11 percent learned about the availability of HD programming from their local electronics stores. This again shows that the local retail electronics outlets are missing an important opportunity to educate the public about the availability of HD programming.

One aspect of the study does concern me, and it centers on what viewers think they have to do to receive HD programming.

There appears to be a viewer perception that HD is only available through the rental of a receiver or STB. Some 45 percent of non-HDTV set owners said they would be more interested in buying an HDTV monitor if they could "rent the set-top box/receiver from the cable/satellite provider for a small, additional fee." Note there is no mention of free over-the-air reception.

Among those planning to purchase an HDTV in the next six months, a whopping 75 percent would be even more interested in buying an HDTV monitor, if they knew they could "rent" the set-top box.

All this hints that consumers may mistakenly believe that HD programming is strictly a subscription-based service. They also may wrongly assume that HD receivers are expensive, hence their desire to rent one.

Unfortunately, this study supports my own experience. In all my travels this year around the country, I have never seen an analog television station promote their own digital service. That tells me a lot about how little these stations value their digital signals. Worse, it does nothing to promote the technology that represents their future.

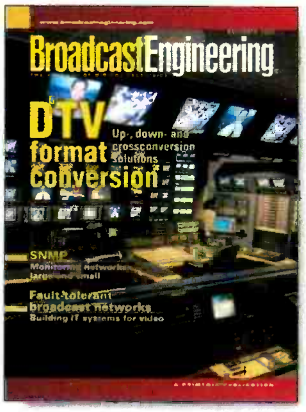
If broadcasters won't promote HD as a free, off-the-air service, why would a consumer ever bother to install an antenna? After all, they are being told by cable that HD is a subscription service. BE

Brad Dick

editorial director

Reader Feedback

An accurate test?



To the editor:

I read with great interest your November article entitled "Dolby Pro Logic II vs. SRS Circle Surround." While we at SRS appreciate the positive points made about Circle Surround, we have some serious concerns about the accuracy of the article.

Regarding the steering torture test, the Circle Surround decoder was designed to provide highly stable and accurate steering under a wide range of real-world conditions. In direct comparison tests performed at SRS Labs, we found that on both Dolby-encoded and Circle Surround-encoded music and movie soundtracks, the Dolby DP564 decoder exhibited transient steering instabilities that were not evident with the Circle Surround decoder.

As a result of the design decisions made to provide highly stable steering, the Circle Surround decoder may not respond as quickly to high-speed transient material moving between the channels. Due to the complex nature of steering trade-offs made in matrix surround solutions, it is quite possible to create test material that confuses the steering logic of any decoder. Depending on the test material and the decoder's particular algorithm, one decoder may fail a test that another decoder passes, while different source material would cause the opposite result. Because of this, we believe the kick drum portion of your testing did not represent a real-world situation that accurately reflects what users would experience with normal use of the system.

ALAN KRAEMER
SRS LABS

Ken Pohlmann, director of the music engineering program at the University of Miami, responds:

Pro Logic II and Circle Surround were subjected to the same test signals, and the results were interpreted independently, without any editorial influence by either SRS or Dolby Laboratories. We stand behind our test methodology and our independent assessment of the results.

Job loss

To the editor:

I find it hard to believe that you would support the FCC's push to further station consolidation. You must not talk to many folks that you don't see at NAB. The issue is job loss. The fact is that laying people off saves money, props up earnings, makes shareholders (the folks you DO see at NAB) happy and feeds the juggernaut of technology.

The New York Times Company digital operating center runs about 11 stations from a control room in Norfolk, VA. Is it technically feasible? Yes. Is it cost-efficient? Yes. Is it humane? Not to the people who lost their jobs over it. The operators that work at the DOC are simply asked to do more for the same pay. I know they stopped coming to our SBE luncheons when we raised the price to $10 per person; I don't know any who own HD sets either.

I realize that technology will progress whether we want it to or not. I don't advocate that we should return to the days of three-person camera crews, or one operator per tape machine. My point is that so many technicians already work for janitorial wages. Job loss through consolidation just puts the actual mop in their hands.

CHARLIE FARR
VIRGINIA BEACH, VA **BE**

September Freezeframe:

Q. Who was the FCC chairman *Broadcast Engineering* magazine referred to as "the most disliked chairman ever" for his actions on broadcasting?
A. William Kennard

October Freezeframe:

Q. Can you answer this question from one of Michael Robin's recent columns: What is the vertical resolution of a 1920x1080/60i format signal expressed in LPH?
A. 756 lines per picture height (LPH)

November Freezeframe:

Q. What were the names of the two incompatible digital video disc formats that were later standardized into what is now officially called the digital versatile disc (DVD), and when was the format officially launched? (Hint: The format war was between Toshiba/Time Warner and Sony/Philips.
A: SD from Toshiba/Time Warner and MMCD from Sony/Philips. Officially launched at the Winter CES show, January, 1996.

Winners:

September — Garen Braun
October — Augusto Villasenor, Globecomm Systems

Test your knowledge!

See the Freezeframe question of the month on page 6 and enter to win a *Broadcast Engineering* T-shirt.

Send answers to *bdick@primediabusiness.com*

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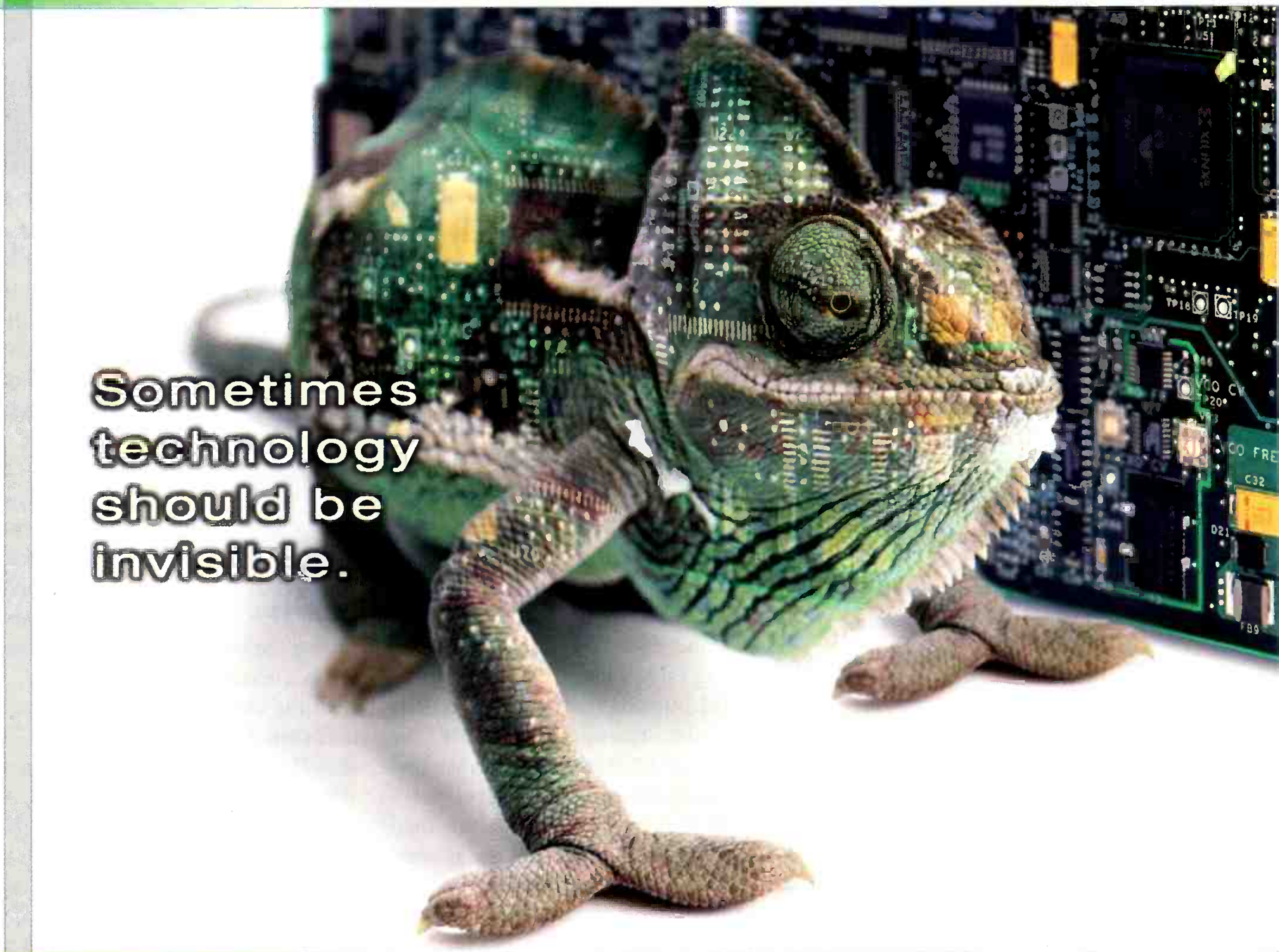

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BEYOND THE HEADLINES

50 years of progress?

BY CRAIG BIRKMAIER

Did you know that NTSC just celebrated its *golden* anniversary? On Dec. 17, 1953, the FCC adopted the "compatible color" NTSC standard.

On Dec. 30, 1953, Admiral announced a 21-inch color console for $1175, but it was not the first color TV

Admiral's 21-inch color console sold for $1175 in December 1953.

to ship. Many collectors consider the 15-inch RCA CT-100 to be the first compatible color TV offered for sale; the price tag was $1000. But Westinghouse introduced a 15-inch color TV several weeks earlier at a price of $1295.

It took another decade for NTSC color TV to reach critical mass as a consumer product. Four decades later, NTSC is still going strong, delaying one of the last major transitions from analog to digital content distribution. (It is not surprising that the other holdouts are AM and FM radio broadcasts, and analog cable TV.)

RCA's CT-100 is considered by collectors to be the first colorTV sold. It cost $1000.

IBM introduced the first magnetic hard-disk drive on Sept. 13, 1956. The 5MB IBM 305 Random Access Method of Accounting and Control drive (RAMAC) was not for sale, but could be rented for only $3200 per month. IBM estimates that today's dollar cost per megabyte of that disk would be $100,000 or $100 million per gigabyte.

IBM projects that the cost for one gigabyte of hard-disk storage will be 23 cents in 2006, the 50th anniversary for the hard disk. This represents a cost reduction of more than 400 million to one!

If NTSC color TVs had declined in cost by the same factor, you would be able to buy 4000 13-inch color TVs for one penny today! Somehow, this makes the fact that you can buy *one* 13-inch color TV for $69 today a little less amazing.

Fortunately for the manufacturers of consumer electronics products, displays are not following the same geometric progression that is driving the cost of devices that process bits in a relentless downward spiral.

On the other hand, some view it as unfortunate that traditional professional video equipment manufacturers are caught up in this digital spiral. Customers of these companies may find this downward pricing pressure to be good news however. It means the tools of the video trade are growing in capability, even as the prices tumble. But it's a zero sum game for manufacturers — there is no way to survive this ride when the number of professional customers is NOT growing, and revenue per unit is declining every year.

Meanwhile, less-tradition-bound companies are riding this downward spiral, and in doing so, are changing the landscape of digital television. At NAB2003, companies such as Avid, Apple and Discreet Logic offered software-based tools for video editing, special effects and composition — tools that are equally capable of cranking out an NTSC news story in the back of a HumVee crossing the Iraqi desert, or an HD movie in a Hollywood studio.

It's only software

Jan. 22, 1984, is another important date in television history. This was the year

FRAME GRAB A look at the issues driving today's technology

DSL prices dropping

Countries cut prices 25 percent from last year

	Start	September 01	March 02	October 02	March 03	September 03
NTT (Japan)	100	110	120	72	64	56
Verizon (USA)	100	125	125	140	100	78
BT (UK)	100	100	75	75	75	69
Deutsche Telekom	100	88	88	48	58	58
Global index	100	110	113	112	105	84

Source: Point Topic *www.point-topic.com*

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that Apple ran the now famous 1984 advertisement launching the Macintosh. It also was the year that I used one of the new Macs to help with the introduction of the Grass Valley Group Model 100, almost 20 years after Intel's Gordon Moore observed that the number of transistors one could put into an integrated circuit would double for the same cost every 18 months. The Model 100 took advantage of microprocessors and software to create a platform optimized for linear video editing under the control of a computerized editing system.

Control is the operative word here. The computerized editing systems of that era used microprocessors and RS-422 serial links to control many of the devices in a million-dollar linear edit suite, including the source and record linear tape machines, the video switcher and some form of audio-follow-video mixer. Together with a new generation of lower-cost products aimed at the emerging business and industrial video markets, the Model 100 made it possible to create a computerized A/B roll editing system for less than $100,000.

On Jan. 22, 1984, Apple launched the Macintosh computer with its now-famous commercial during the Superbowl.

While I was busy at NAB1984 with the Model 100 introduction, there were two other product introductions that caught my attention: the Montage Picture Processor and the Lucas Arts Edit Droid. These *nonlinear* editing systems used banks of VCRs and laser disc players respectively, to simulate random access to source material. Montage introduced the use of picture labels on a timeline.

Despite the fact that the personal computer revolution was now in full swing, it never occurred to me that it would be possible to edit video without some form of linear recording devices. A single frame of video could gobble up nearly all the memory available in a PC in 1984. The ability to store and play video from a hard disk drive seemed impossible in 1984.

By 1990, digital video compression was beginning to show promise, and the impact of Moore's Law on anything digital was beginning to sink in. With compression we could store video on the hard disk drives of a personal computer. We could now put the guts of a video editing system inside a PC, using a few expansion cards to handle the video compression and video processing. Avid was one of the first companies to market with a compression-based nonlinear editing

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DPA MICROPHONES

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system. It soon became clear that it would only be a matter of time until somebody developed an online-quality nonlinear editing system.

That milestone was passed in 1995, when Media 100 delivered the first online-quality nonlinear system. That same year, the FCC adopted the ATSC digital television standard, with its computationally intensive HDTV formats. Traditional video equipment vendors re-invented the million-dollar edit suite to support HD editing.

Assuming that HD is six times the resolution of NTSC, one could extrapolate that online nonlinear editing of HD would be possible in about four years. Turns out that this was overly pessimistic, since hard disks have been doubling in capacity every 10 months since 1994. The hard-disk revolution, together with faster processors and more RAM, made it practical to handle uncompressed SDTV editing in real time by 1999. Uncompressed HDTV editing is now a practical reality.

But that is only one aspect of this story. Treating video as just another form of data has had an even more profound effect on the creation of special effects and graphics. We now manipulate visual objects within a composition directly, rather than trying to control switchers, DVEs and character generators. These products are now used only for live video production, while many of the visual elements that they integrate are pre-produced using computer-based tools.

Hard-disk arrays have been used to record uncompressed HD files from 24p camcorders for more than a year. Another milestone will be passed in 2004 as professional video acquisition systems move from linear tape to random-access optical discs and solid-state memory (flash RAM). Soon it will be possible to take a PCMCIA acquisition module out of your camera, plug it into a notebook computer and edit video … using *only* software. **BE**

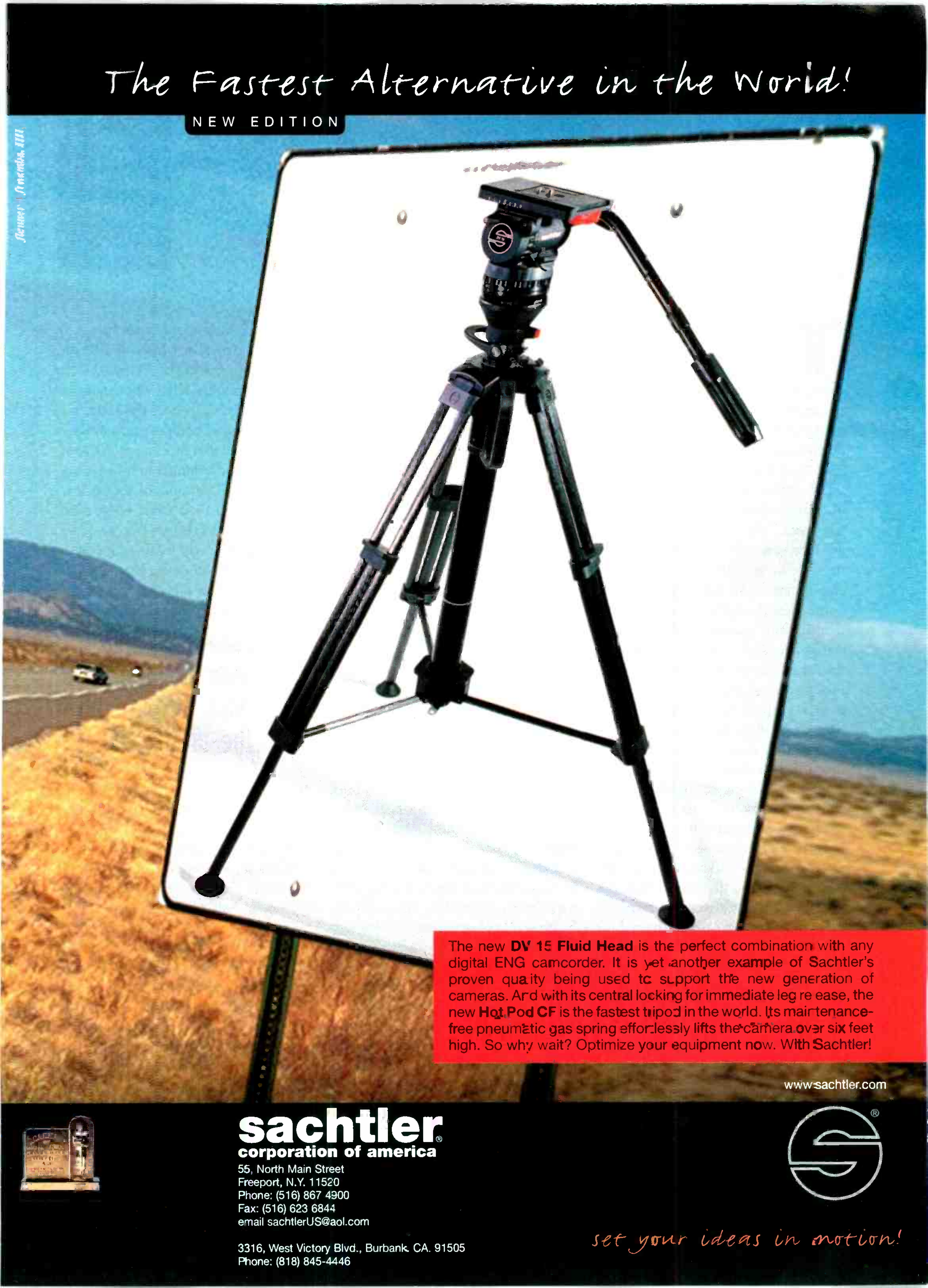
Craig Birkmaier is a technology consultant at Pcube Labs, and he hosts and moderates the OpenDTV Forum.

SEND **Send questions and comments to:** cbirkmaier@primediabusiness.com

Web links

National Television Systems Committee
www.ntsc-tv.com/ntsc-index-01.htm

Projecting the Cost of Magnetic Disk Storage Over the Next 10 Years
wwww.berghell.com/whitepapers/Projecting%20the%20Cost%20of%20Magnetic%20Storage%20Over%20the%20Next%2010%20years.pdf



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FCC acts on DTV extension applications

BY HARRY C. MARTIN

The full commission recently granted additional third-time extensions to complete construction of digital television facilities to a group of 104 stations, while it denied extensions to seven others and deferred any decision with regard to 30 TV satellite stations.

The commission accepted a variety of justifications for the requested extensions. They included adverse weather, unexpected equipment failures, delay or failure in delivery of equipment, and natural disasters. Some stations claimed they faced difficulties in obtaining necessary local, state or federal approvals needed for the construction of new towers, although the stations involved have diligently sought to overcome those obstacles. Other stations were said to be awaiting commission action on modification applications, channel change rule-making proceedings, special temporary authorization (STA) requests, or assignment applications. Further extensions were granted to another group of stations due to ongoing financial difficulties, which the stations said they were working to resolve. Some group owners had proposed, among other plans, a staggered timetable for completing construction of their multiple stations.

Thirty other stations that operate as "satellites" had their construction deadlines deferred pending the resolution of a rule-making proceeding to determine whether such stations should be allowed to turn in their digital authorizations, forego simulcasting, and simply make a "flashcut" switch to DTV at the end of the transition period.

Seven stations had their extension requests denied. The common thread leading to denial was the commission's conclusion that these stations had not taken sufficient actions during the most recent extension period or had not provided any new reasons to justify further delay. The good news for stations in this group, however, is that they were nonetheless given a final six months to finish DTV construction. The stations were admonished, and they must submit periodic progress reports to the commission. These stations also face the threat of additional sanctions if they fail to submit the required reports, if the commission determines that they were acting in bad faith, or if they fail to commence DTV operation within six months.

All-digital TV tuner rule upheld

All TV sets sold in the United States must include DTV tuners by 2007. That's the final word from the U.S. Court of Appeals, which denied an appeal from makers of TV sets, VCRs and DVD players, all of whom sought to block the FCC's 2007 deadline.

The consumer equipment manufacturers argued that most people do not want or need digital tuners because they get a full panoply of digital features through their cable or satellite providers' set-top boxes. But the court found the FCC had legal authority to impose the deadline on manufacturers. The commission wanted consumers to be able to plug in and immediately use a new TV to receive free over-the-air broadcasts. Without a built-in digital tuner, consumers would have to buy an external decoder if they lacked cable or DBS service.

The commission is phasing in digital-ready requirements. Beginning next year, half of all big-screen TVs larger than 36 inches must have digital capacity. By July 2007, all sets 13 inches or larger, as well as VCRs and DVD players, also must be DTV-ready. Pocket-sized or wristwatch TVs will not be required to have digital tuners — although those that do not come so equipped will require external digital decoders to receive increasingly prevalent DTV broadcasts. BE

The commission wanted consumers to be able to plug in and immediately use a new TV to receive free over-the-air broadcasts.

Dateline

TV stations in D.C., Maryland, Virginia and West Virginia must begin their pre-filing renewal announcements on April 1, 2004, in preparation for filing their renewal applications on June 1, 2004.

Also on April 1, stations in Delaware, Indiana, Kentucky, Pennsylvania, Tennessee and Texas must place their annual EEO reports in their public files.

Harry C. Martin is an attorney with Fletcher, Heald & Hildreth PLC, Arlington, VA.

SEND Send questions and comments to: harry_martin@primediabusiness.com

Composite
video basics

BY MICHAEL ROBIN

In 1941, after many experiments with television, the Federal Communications Commission approved the NTSC standard. This was a revolutionary approach to television. It offered a high resolution of 525 interlaced scanning lines, negative video modulation with a 4.2MHz full upper sideband and a vestigial lower sideband, and FM sound — all transmitted in a 6MHz-wide channel. It also specified a VHF transmission channel allocation in preparation for the expected rapid development of television. By 1948, the VHF channel allocation had undergone several changes, including the disappearance of channel 1 and the introduction of UHF channels 14 to 89.

In 1950, following several years of experimenting with color television, the FCC approved a CBS-proposed sequential R,G,B color television system. This system used a rotating R,G,B segmented color wheel concept, which was incompatible with the NTSC all-electronic black-and-white standard.

The compatibility constraints are:

- *Monochrome compatibility:* A monochrome receiver must reproduce the brightness content of a color signal correctly in black and white, with no visible interference from the color information.
- *Reverse compatibility:* A color television receiver must reproduce a monochrome signal correctly, with no spurious color components.
- *Scanning compatibility:* The scanning system used for color transmissions must be identical to the one used by the existing monochrome service.
- *Transmission channel compatibility:* The color system must fit into the existing monochrome television channel and use the same spacing between the vision and sound carriers.

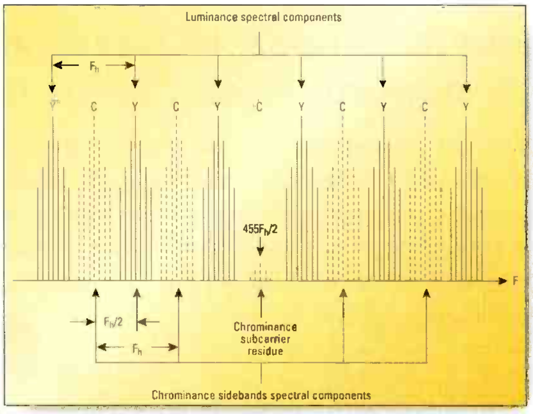

Figure 1. Details of NTSC FDM spectrum around the chrominance subcarrier

NTSC composite video concept

Following several years of experimenting with NTSC monochrome-compatible color television concepts, the FCC approved in 1953 the current analog color television standard. The NTSC system is based on the concept of composite video. Composite video describes a signal in which luminance, chrominance and synchronization information are multiplexed in the frequency, time and amplitude domain for single-wire distribution. The contemporary characteristics are defined in the SMPTE 170M standard.

- *The luminance information:* Monochrome compatibility requires the generation and transmission of a full bandwidth (4.2MHz) luminance electrical signal (E'_Y) representing the brightness component of the image. This signal is obtained by a linear combination of three electrical signals (E'_G, E'_B and E'_R) representing the three primary colors green, blue and red. The prime sign indicates that the respective signal is gamma corrected. The luminance signal is

FRAME GRAB

A look at tomorrow's technology

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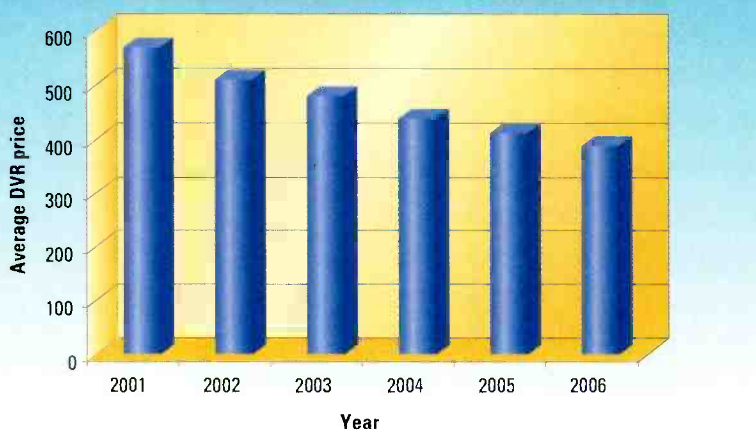
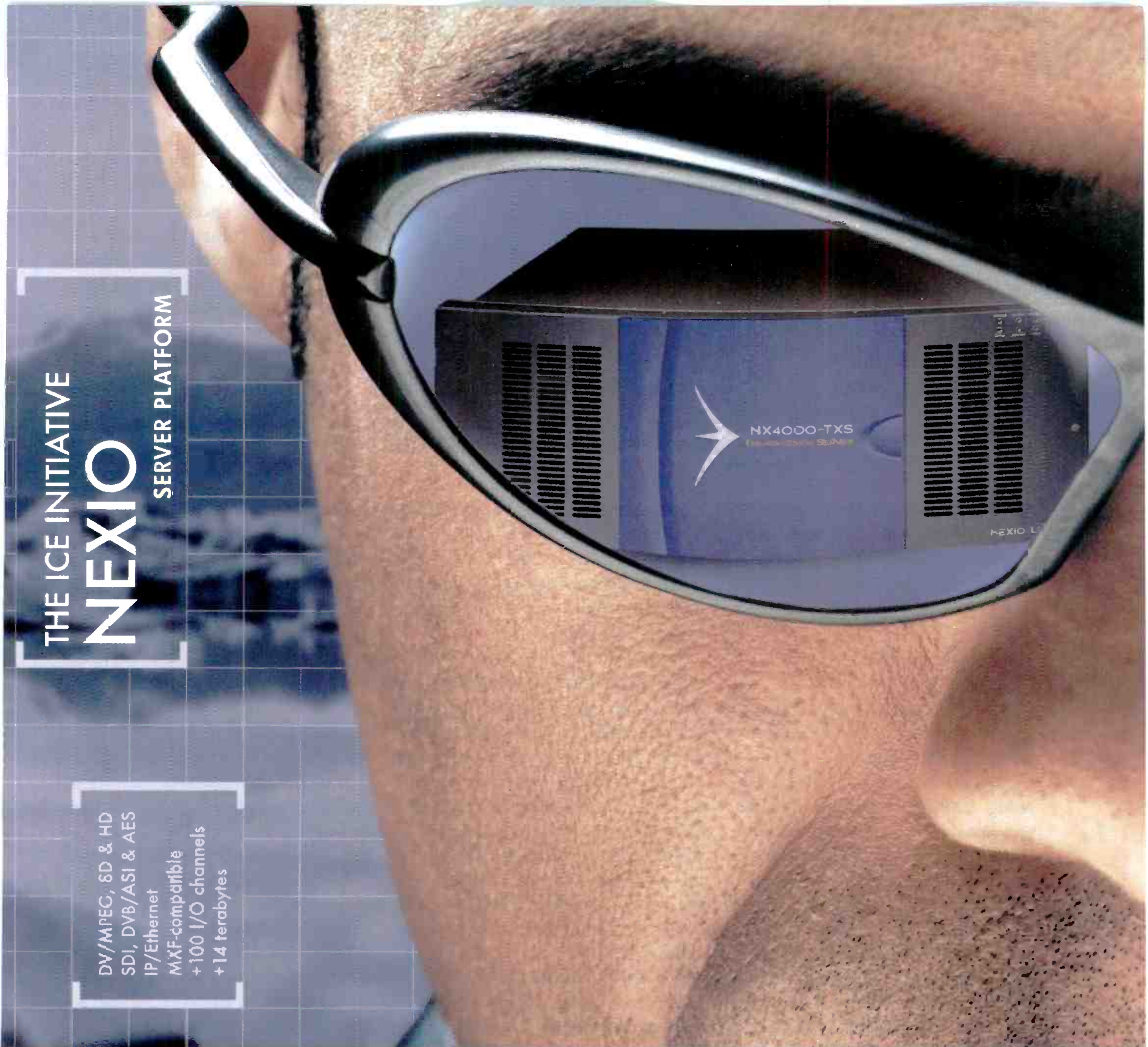


Source: Kagan *www.kagan.com*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represented by the mathematical expression:

$E'_Y = 0.587\,E'_G + 0.114\,E'_B + 0.299\,E'_R$

• *The chrominance information:* The chrominance information is transmitted by two of the primary colors (blue and red), less the brightness component, and are known as the color-difference signals. These signals have a reduced bandwidth, of the order of 500kHz, reflecting the reduced eye resolution. The mathematical expressions for these signals are:

$E'_B - E'_Y = -\,0.587\,E'_G + 0.886\,E'_B - 0.299\,E'_R$

and

$E'_R - E'_Y = -\,0.587\,E'_G - 0.114\,E'_B + 0.701\,E'_R$

The $E'_G - E'_Y$ signal can be recreated in the receiver by a suitable combination of the three signals.

The color-difference is scaled in amplitude by suitable multiplication factors to avoid transmitter overmodulation. The scaled color-difference signals are:

$E'_{B-Y} = 0.493\,(E'_B - E'_Y)$ and $E'_{R-Y} = 0.877\,(E'_R - E'_Y)$

Each color-difference signal modulates an assigned subcarrier. The two subcarriers are of identical frequency (about 3.58MHz) but of different phase. The phase difference between the two subcarriers is 90 degrees, so the original signals modulating the two subcarriers can be demodulated without crosstalk. The two subcarriers are obtained from a common crystal-controlled oscillator. The type of modulation used is suppressed-carrier amplitude modulation. Because the subcarrier is suppressed, only the sidebands are obtained at the output of the modulators. This results in complete cancellation of the chrominance signal when no colors are present.

The system takes into consideration the fact that in an analog video signal's spectrum is not continuous but features clusters of spectral components at the horizontal scanning frequency F_h and its multiples. So the subcarrier frequency (F_{sc}) is chosen to be an odd multiple of half of F_h, resulting in an interleaved chrominance/luminance spectrum known as half-line offset.

Figure 1 on page 20 shows the simplified representation of the NTSC interleaved spectrum around the chrominance subcarrier. It is to be noted that the original monochrome scanning frequencies of 30Hz and 15,750Hz have been altered to, respectively, 29.97Hz and 15,734.25Hz. This was aimed at reducing the visibility of the potential 920kHz beat between the color subcarrier and the audio subcarrier (4.5MHz). Therefore, the subcarrier frequency is:

$F_{sc} = 455F_h/2 = 3{,}579{,}545 \pm 10\text{Hz}$

• *The chrominance synchronization:* A burst of nine cycles subcarrier is transmitted during the backporch horizontal blanking interval to synchronize the receiver's local crystal oscillator.

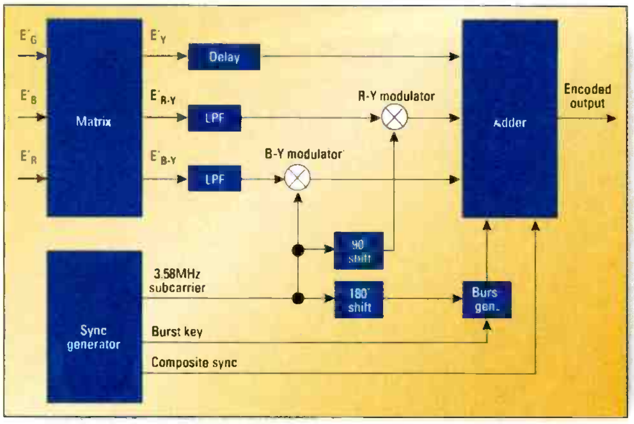

Figure 2. Simplified block diagram of an NTSC B-Y/R-Y encoder

Figure 2 shows a conceptual block diagram of an NTSC encoder using B-Y/R-Y color-difference signals. Green, blue and red signals are fed to a resistive matrix that algebraically combines percentages of the three primary color signals to form the luminance and the two color-difference signals. Each color-difference signal is band-limited before being fed to the respective balanced modulator.

A 3.58MHz subcarrier feeds the B-Y balanced and, through a 90-degree phase-shift network, the R-Y modulator. The adder combines the luminance, chrominance sidebands, composite (vertical and horizontal) sync, and a 180-degree phase-shifted gated subcarrier burst into a composite color signal.

Figure 3 shows a vector representation of the chrominance subcarrier modulation process. A given color, described by a given set of E'_{B-Y} and E'_{R-Y} signal values, is represented by two amplitude-modulated subcarriers in phase quadrature. The instantaneous values of the two modulated subcarriers result in a vector described by its amplitude and phase angle with respect to the B-Y subcarrier reference phase. The vector amplitude represents the color saturation, and its phase angle represents the hue.

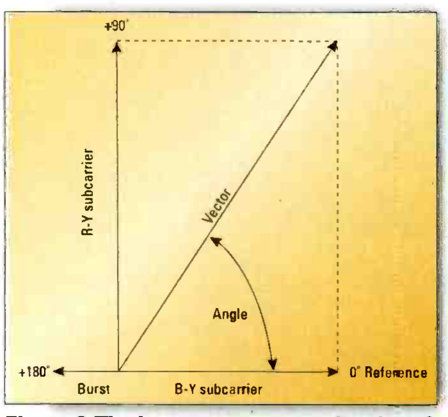

Figure 3. The instantaneous amplitudes of the subcarrier result in a vector whose amplitude represents saturation and phase represents hue.

Problems with NTSC

NTSC was a compromise aimed at squeezing color information into a 6MHz monochrome television channel. The solution was brilliant, but the electronic tube technologies of the time were at best inadequate and at worst unacceptable. Solid-state technologies have removed many of the early problems. Here are a few of the problems:

•*Transmitter overmodulation:* The color-difference signals are scaled to avoid transmitter overmodulation. The video transmitter is modulated in amplitude and uses negative

modulation. In a negative modulation system, increasing the brightness of the transmitted picture produces a decrease of the modulation envelope amplitude.

The picture modulation envelope has four reference levels: peak white level, black level, blanking level and sync level. Figure 4 shows the NTSC reference levels as used in North America. White level (100 IRE) reduces the carrier to 12.5 percent. The carrier cancels at 120 IRE. Saturated yellow and cyan colors can produce video signal levels of 130.8 IRE, resulting in carrier cancellation and inter-carrier "buzz." Because saturated yellow and cyan colors do not normally exist in nature, camera-generated video signals would not create problems. However, synthetically generated signals (100 percent color bars or character generators) could create problems.

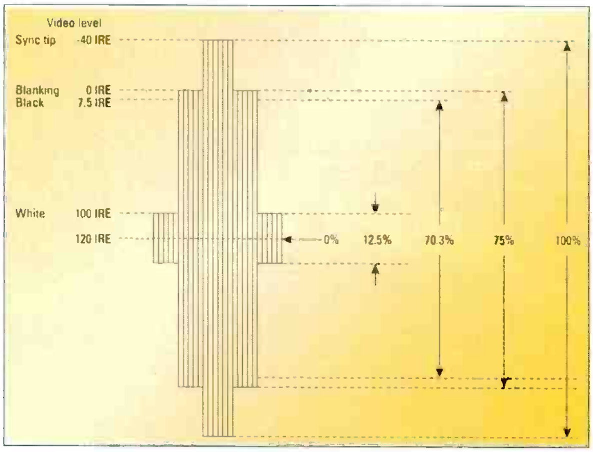

Figure 4. Significant video signal levels shown as a percentage of carrier amplitude in negative amplitude modulated systems

- *Video signal distortions:* Analog composite video signals are subjected to various types of cumulative distortions and noise. Separate distortions of the luminance and the chrominance components as well as inter-modulation between them are likely to occur. PAL is more tolerant of luminance/chrominance inter-modulation. Such distortions can be reduced by performing all, or at least a major part of, production operations using component video signals. **BE**

Michael Robin, a fellow of the SMPTE and former engineer with the Canadian Broadcasting Corp.'s engineering headquarters, is an independent broadcast consultant located in Montreal, Canada. He is co-author of Digital Television Fundamentals, *published by McGraw-Hill, and recently translated into Chinese and Japanese.*

SEND **Send questions and comments to: michael_robin@primediabusiness.com**

Networking fundamentals

BY BRAD GILMER

This month's article is written for people who are just getting to know computer networking, or for those who want to increase their knowledge of the basics.

Computer networks were invented to connect computers together to allow them to share resources such as files and printers. Of course, networks have been around for quite some time. Early network implementations were proprietary (because there was nothing else). The networking capability was written into the application (an accounting system for example), and the choice of network protocol (communications software) and hardware was hard-coded into the application package. But this created problems. If the user or manufacturer wanted to change any of the networking components, the core application had to be rewritten. When networking really took off, it seemed that there was a "protocol flavor-of-the-month." Things were changing so fast that it became impractical for application vendors to keep up. There had to be a better way.

In response to this problem, engineers developed the open systems interconnect (OSI) layer model for networking. This layered model allows the application (an accounting program, editing application, etc.) to remain separate from the layers below. This way, software protocols and hardware can be upgraded without having to rewrite the overarching applications. The application then interacts with the protocols through a software interface called an application programming interface (API). Standardization of the API allowed manufacturers to substitute different technology at lower layers without having to overhaul their applications.

The layered model in Figure 1 illustrates another fundamental concept in networking. Note that the protocols are a separate layer from the physical layer. This allows a given networking technology such as Ethernet to be implemented over different physical media. For example, users could implement Ethernet using unshielded twisted pair (UTP) or optical fiber. In fact, these different physical media types could be mixed within a network. The signals riding on these different media types are Ethernet. The layered approach to networking makes this possible.

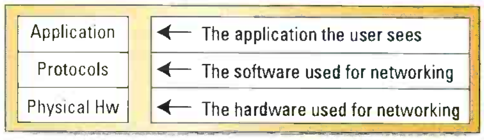

Figure 1. Simplified layered model.

It also is possible to select protocols independently from the physical hardware upon which these protocols are transported. For example, both Ethernet and Fibre Channel can be carried on fiber.

There are many variations of the OSI model. The most common has seven layers: physical, data link, network, transport, session, presentation and application.

Computer networks were invented to connect computers together to allow them to share resources such as files and printers.

While it is not important to understand what all these layers do, you should know that there are fundamental differences in how network signals are moved, and that many of these differences center around whether switching decisions are made at Layer 2 or Layer 3. It is not always possible to make a clear distinction between the different layers. There are many excellent OSI model tutorials available on the Internet.

Network protocols

The two dominant networking technologies these days are Ethernet and Fibre Channel. Ethernet, a packet-based networking technology, has by far the largest technological deployment. Data from an application is sent to the protocol layers. In these layers, the data is chopped up into packets. Next, a destination address is put on the front of the packet, and the packet is sent to the physical layer for transportation on the network.

Figure 2 shows a simplified Ethernet packet. Thousands of these potential Ethernet packets are generated by a computer each second and shipped across the network, each packet traveling independently. The address on the packet allows the network to route the packet to its destination. The protocol layer at the destination computer is responsible for reassembling the packets in the proper order and presenting the application with the original data.

Figure 2. Simplified Ethernet packet.

Ethernet is used ubiquitously both for intranets (networks that are local to a given facility), and on the Internet. The Internet (capital "I") is comprised of a large number of networks and switching technology that allows computers to send data across the country or around the world. While the switching and scope of these networks is vastly

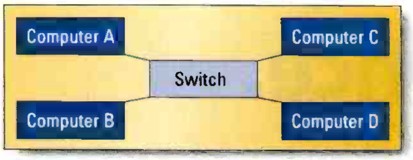

Figure 3. Hub-and-spoke Ethernet network.

different from that of an intranet, the basic Ethernet packet remains unchanged. In fact, usually the same Ethernet packet travels across a local intranet, through a gateway computer and on to the Internet.

There are many different Ethernet topologies. Topology refers to how computers in the network are connected together. The most common topology is called hub-and-spoke, in which each computer has a single, dedicated Ethernet connection to a central Ethernet switch. (See Figure 3.) If Computer A is transferring files to Computer B, it can do this at full speed while Computer C is transferring files to Computer D.

A star network is easy to build and troubleshoot, and it can provide high bandwidth to the desktop if it is designed properly. But there are caveats. To get the maximum bandwidth between devices connected to the network, the switch itself must have the capacity to operate at double the bandwidth of the individual connections to the computers. In our example, if this is a 100Mb/s network, the switch must have at least 200Mb/s of available bandwidth.

Fibre Channel is a computer network that is frequently confused with Ethernet. They are two separate, and incompatible technologies created to solve different problems. The confusion arises because they both can run on the same physical network. It looks as if you can just plug a Fibre Channel cable into an Ethernet fiber switch. But this will not work. The two networks use fundamentally different protocols or language to talk, and they come from different origins. Fibre Channel was created to connect computers to disk drives. In the early days of computing, there were strict limits on how far the disk drive could be physically located from the computer itself. Remember, CPUs sat in one box, and storage sat in another box. As computers got faster, they needed faster connections to the disk drives that served them. Parallel connections to drives became the norm. But this too reached a practical limit as the lengths of parallel cables started to give rise to termination problems, RF crosstalk, and poor frequency response. Computer designers needed a cable extender for disk drives that could be easily supported on existing systems. At this time, the Small Computer System Interface, or SCSI, was being used for many high-performance drives. Network engineers went to work designing a computer network that could transport SCSI commands. They came up with Fibre Channel — a network that established virtual connections between devices, allowing the robust transmission of SCSI commands across virtually unlimited distances. Now, Fibre Channel is the predominant local network in use for the connection of high-speed peripherals to computers.

There are a number of other networking technologies in use today, including Firewire and wireless. These networks are usually variations on the theme of packet-based interconnections created to allow the transfer of data from one computer system to another. If you do not know where to start, you might consider enrolling in a basic networking course at a local community college. You might also consider purchasing a couple of inexpensive computers and a switch and see what you can do. There is nothing like hands-on experience. **BE**

Brad Gilmer is president of Gilmer & Associates, executive director of the AAF Association and executive director of the Video Services Forum.

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Program loudness

What satisfies listeners?

BY JEFF RIEDMILLER

Today, many television viewers experience audio level discrepancies in programming that far exceed what most would consider acceptable. Presumably there is some loudness range, or comfort zone, within which a typical listener will accept loudness changes within and between programs. Assuming that the non-speech elements of programs are appropriately "balanced" around speech, listeners will not be annoyed if the speech elements fall within their individual comfort zone. To the best of our knowledge, the magnitude of this comfort zone has never been determined. So we undertook a series of subjective experiments to define it.

The importance of speech

During our research, it became apparent that listeners agree with each other more consistently when evaluating content that primarily contains speech. When listeners evaluated other types of program content, such as music and/or sound effects, they sometimes disagreed widely. Figure 1 compares the results of 21 listeners evaluating the level of an audio program containing speech and one containing only the sound of footsteps compared to a reference. Nineteen out of 21 listeners agreed with each other to within 1dB when evaluating speech. However, when the listeners evaluated the footsteps item they disagreed with each other by up to 12dB! One listener indicated that the footsteps item was 3dB too quiet, while another indicated that it was 9dB too loud. From this, we concluded that adjusting the speech portions of programs to a consistent loudness will lead to greater listener satisfaction.

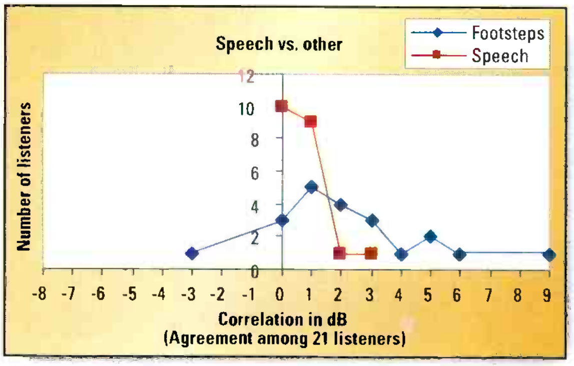


Figure 1. Agreement among listeners when evaluating speech items vs. other signal types, such as music or effects

Defining the comfort zone

A second experiment placed listeners in a typical listening or viewing situation. The subjects were presented with several paired, monophonic reference and test program samples, reproduced by a single loudspeaker in front of them. They were instructed to adjust the master playback level until the reference item (speech) was reproduced at what they considered a "comfortable volume." The experimenter then asked them to set the test volume control to one of the six points shown in Figure 2. The questions were asked in random order, and were also randomized between subjects.

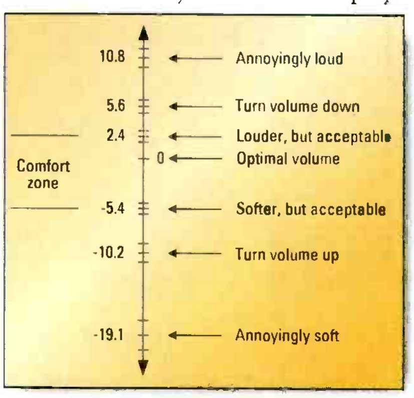


Figure 2. Relative loudness (in dB) of the listening levels investigated, with 95 percent confidence intervals.

From the results it's clear why television broadcasters have been plagued by complaints of "loud ads." An increase of only 2- to 3dB in subjective loudness is enough to move a program out of the typical listener's comfort zone. There is much more latitude on the softer side of the "optimal volume" point. The results of this experiment assisted us in developing the requirements for a useful loudness meter, as well as in offering guidance to broadcasters about what their listeners might find objectionable.

Broadcast and post-production personnel often overlook the importance of speech loudness while assessing program levels. And many of the traditional measurement methods and devices in use today do not specifically consider the dialogue portions of the signal. Yet the need for better loudness management in content creation and throughout the broadcast process is well recognized. And we believe that the best results can be achieved by measuring and normalizing content based on the level of speech, utilizing an objective loudness measure.

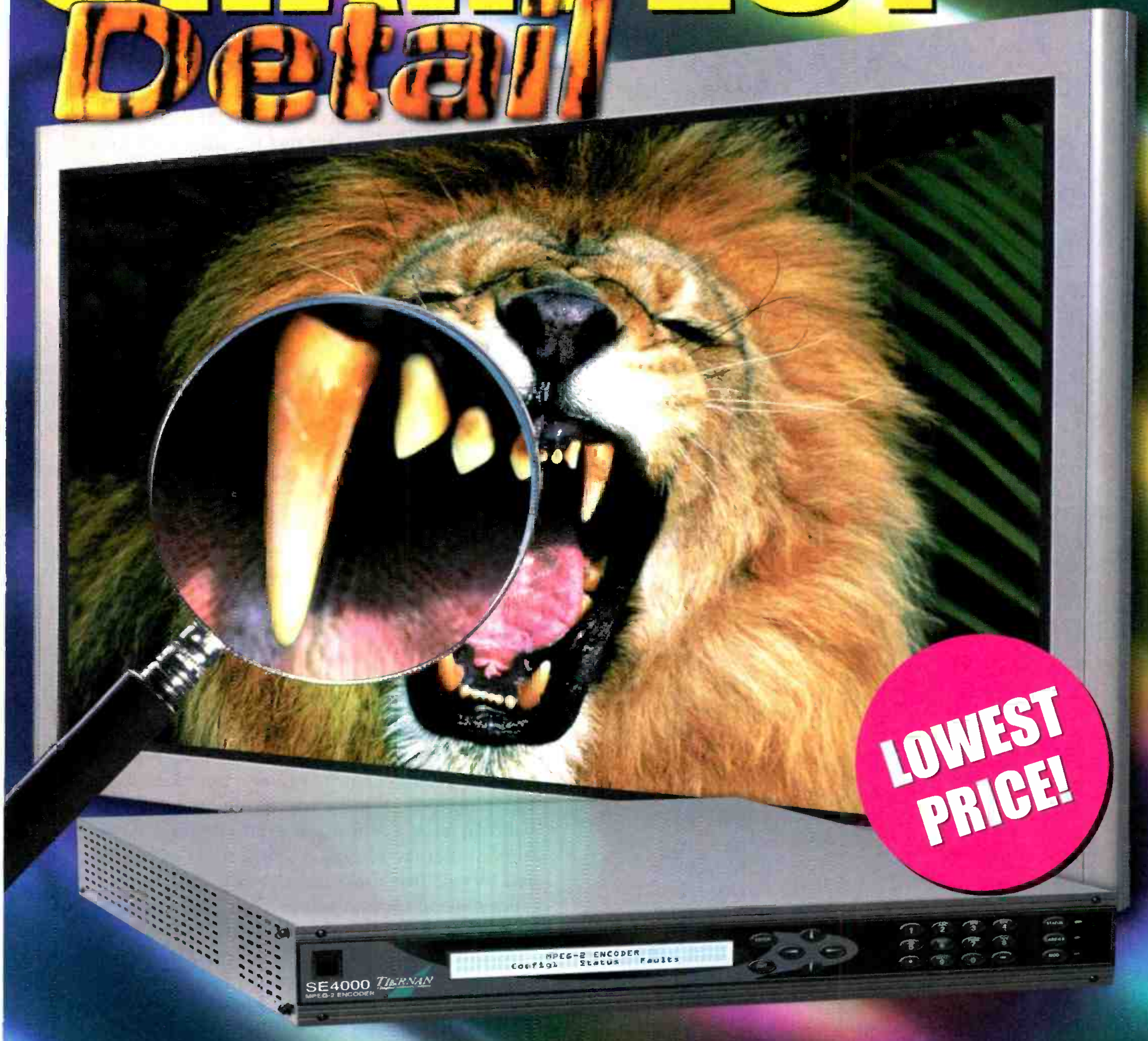
A more detailed explanation can be found in the AES paper "*Intelligent Program Loudness Measurement and Control: What Satisfies Listeners?*" BE

Jeff Riedmiller is broadcast product manager at Dolby Labs.

IN ADDITION

For an expanded version of this article, visit our Web site, *www.broadcastengineering.com.*

SHARPEST Detail



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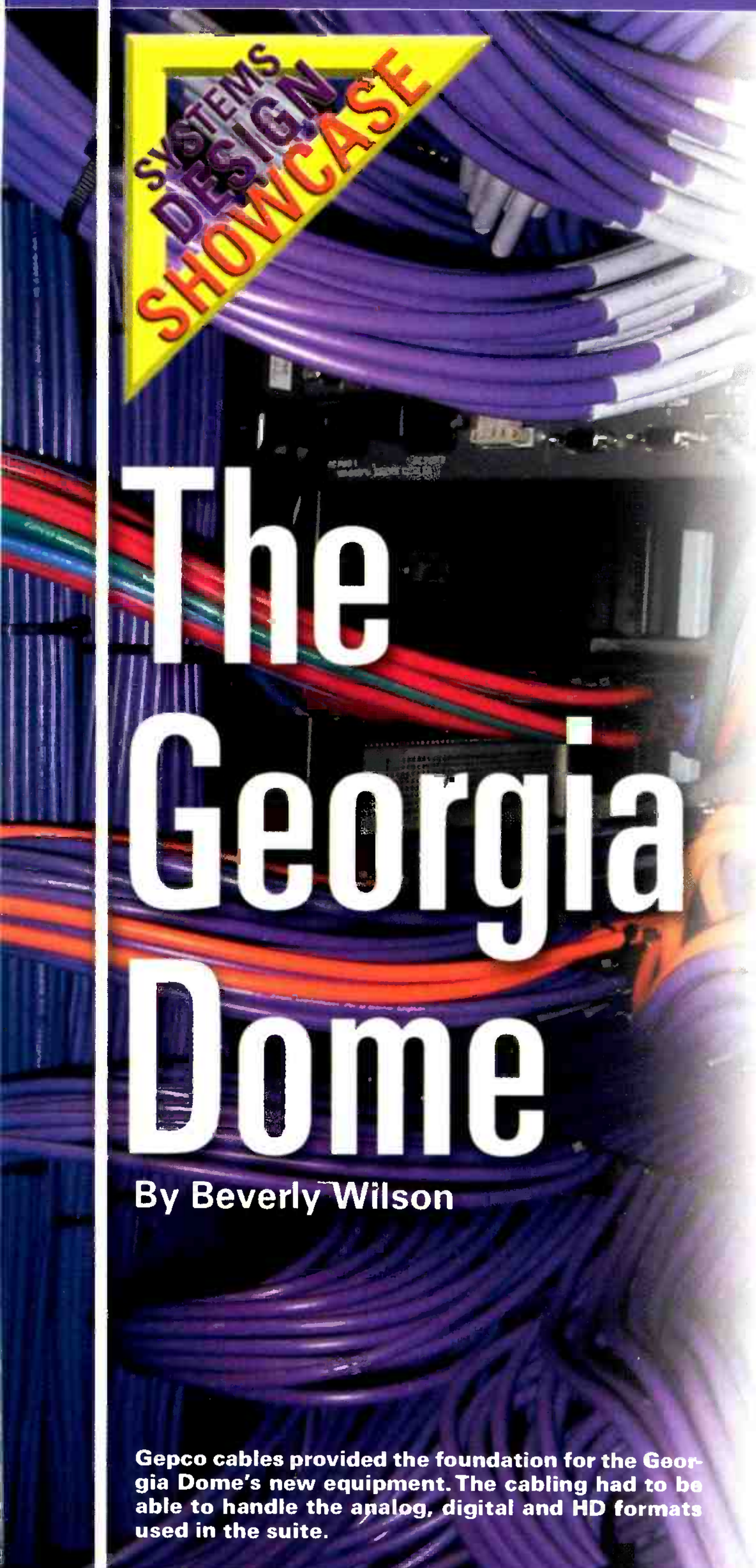


SYSTEMS DESIGN SHOWCASE

The Georgia Dome

By Beverly Wilson

Gepco cables provided the foundation for the Georgia Dome's new equipment. The cabling had to be able to handle the analog, digital and HD formats used in the suite.

The Georgia Dome was built in 1992 as a multi-purpose stadium and home to the NFL's Atlanta Falcons. When the state-owned facility opened, Georgia Dome Productions was created for all in-house broadcast needs.

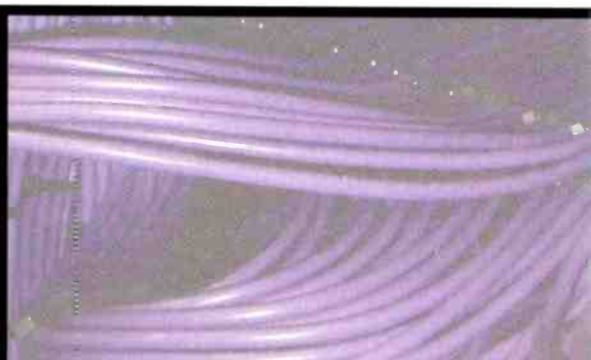
Any facility associated with the NFL must have broadcasting capabilities that comply with the league's rigorous standards. This meant that the antiquated analog systems in the stadium's control suite had to be upgraded to SDI, and its broadcast infrastructure prepared for an upgrade to high-definition in the future.

The suite, operated by Georgia Dome Productions, produces its own in-house show on game day. While it is relied upon heavily for productions, the Georgia Dome has two LED video boards and over 500 monitors, it also receives a broadcast feed from VyVX for league highlights shown on the same monitors. Another aspect of the Georgia Dome that separates it from many other NFL stadiums is its ability to broadcast outside of the facility. The control suite, which can handle uplinks as well as downlinks, has a fiber line that runs directly out of the room to parent company Crawford Communications' satellite teleport.

Most control rooms throughout the NFL are only used from August to January and then are stored away until the next season, but the Georgia Dome is used year-round. It hosts events such as Supercross, NCAA SEC championship football and basketball, NCAA men's and women's basketball, professional bull riding, concerts, and conventions. The facility's full-time use stressed the need for an upgrade to a higher-quality system.

The control room, originally had linear editing equipment supplied by Crawford Communications, including a Grass Valley routing switcher; an 230 Ampex video switcher, an ACE editor and ADO-1000 digital effects from Ampex; an Abekus A42 still store; and BVW75 and BVW65 Beta decks and a ¾-inch VTR from Sony. Since some of the gear was more than 20 years old, it was time to bring the suite up-to-date.

Comprehensive Technical Group (CTG) was contracted by Georgia Dome Productions to perform the installation and system integration. CTG was hired on June 6, 2003 and had to have the room up and running by the Falcons' first preseason game on Aug.



9, 2003. However, the actual installation had to be finished closer to Aug. 1, 2003, to allow the stadium crew a week to become accustomed to the new setup.

CTG began with a two-stage design process and turned to an assortment of Thomson Grass Valley products. A Zodiak 64-input production switcher was one of the main units in the installation. Other Thomson Grass Valley units included a Concerto routing switcher, framed at 128x128, but populated at 64x64, and a GVEous DVE.

The upgrade also allowed the suite to get away from the traditional monitor wall found in most control rooms and move to an Evertz multiview processor, which is displayed on three Mitsubishi LCD monitors. There are still some standard monitors in the suite for program previews and tests, but the majority of monitoring is handled by the 40-inch LCDs. The Evertz multiview processor is easily reconfigured for the facility's events.

One of the constants when performing the various aspects of the overhaul was the use of Gepco audio and video cables. It's one thing to upgrade to high-tech A/V equipment, but if the material that connects it all is faulty, then the new gear becomes irrelevant. The cabling had to be able to handle the analog, digital and HD formats used in the suite. A combined total of 40,000 feet of Gepco's VPM2000 and VSD2001 cables were used in the upgrade.

CTG supplied the suite with four Leitch DPS-575 frame synchronizers in order to integrate feeds into the in-house production. The room also receives feeds from several cameras throughout the stadium, providing the crowd with the same views and angles that the referee has for instant-replay challenges during the game.

With the suite located on the press box level of the stadium, space was at an expensive premium and was a major factor in the room's design. The tight parameters of the room are analogous to what one would find in a large broadcast truck, so it was decided to keep the design and equipment consistent with a standard remote truck. Therefore, this design also provided a familiar layout for the freelancers who are often hired.

In addition to upgrading the production equipment, Georgia Dome Productions also wanted to update the editing equipment. Previously the facility was using an Ampex ACE editor that was physically located in the production control room. An Avid Media Composer was added, and it allows individuals to operate separately from the control room.

With the suite located on the press box level of the stadium, space was at an expensive premium.

To handle the new digital formats, as well as the remaining analog units, the production suite was equipped with a Sony IMX deck, which allows the playback of legacy tape formats such as Beta, Beta SP and DigiBeta. The Sony IMX further increased the facility's versatility and ability to manage multiple formats with ease.

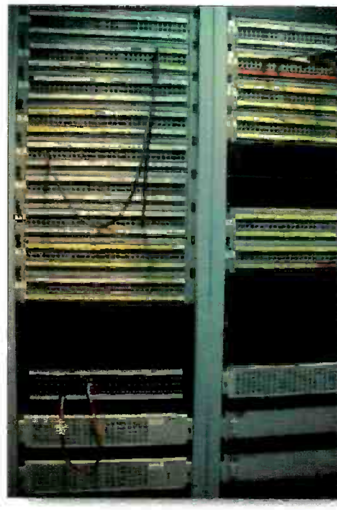
The Georgia Dome chose the Evertz MVP multivideo processor, with three Mitsubishi LCD monitors for display instead of a traditional monitor wall found in most control rooms.

The installer could have brought in enough equipment either to bring the entire control room suite up to date, or to change everything over to HD. Considering the numerous clients that the Georgia Dome services aside from NFL football, CTG opted to upgrade the room, while taking the first step in HD preparation. When the time comes for a complete upgrade to HD, the suite will only need

SYSTEMS DESIGN SHOWCASE

a few extra matrixes for the routing switcher.

As the season closes for the Atlanta Falcons, the upgrade has been a success. The new equipment has been easier to use and created a more reliable production and editing environment. In 2004, the Georgia Dome will play host to the Chick-Fil-A Peach Bowl, Monster Jam and Honda's "Battle of the Bands" 2004 invitational showcase. **BE**



ADC video patch panels were chosen for the job since they are rated for HD signals.

Beverly Wilson is operations manager for the Georgia Dome.

Design team

CTG:
- Jim Wile, owner, project engineer
- Steve McCormick, owner, sr. engineer
- Jonathan Miller, lead installer
- Ry Alford, sales, project manager

Georgia Dome Productions:
- Beverly Wilson, operations manager

Crawford Communications:
- John Bradford, chief engineer, post production

Technology at work

Thomson Grass Valley
- Zodiak production switcher
- Concerto router
- GVEous DVE

Mitsubishi LCD monitor
ADC patch panels
Ensemble Designs SDI-to-NTSC converter transcoder
- A/D converter

Leitch DA and DPS-575 frame sync
Marco production and CC custom camera consoles
Evertz SDI optical converter and MVP monitor wall processor
Ikegami color and B&W monitors
Tektronix
- portable waveform monitor
- SDI waveform monitor and sync generator

Ross GVG 110 digital upgrade kit
Fast Forward Video DDR
Sony IMX VTR
DNF Controls VTR controller

Peanut whistle DTV

BY DON MARKLEY

It is common knowledge that many stations have delayed broadcasting at full authorized power and are operating under an STA at much lower power levels. The FCC's only requirement is that they provide a city-grade signal level over the city of license. These little stations are doing a pretty good job, and the service is much better than many expected. The required signal levels for low-power operation are 35dBu for low-band VHF, 43dBu for high-band VHF and 48dBu for UHF, all based on FCC F(50,90) values.

By the way, "peanut whistle" is a derogative term that used to be applied to any ham station operating with low power, primarily those hams that felt they needed a kilowatt to communicate across town.

Since the commission determined DTV standards, naysayers have predicted that the system wouldn't work and that the horizon was a definitive limit on any possible service. All had one belief in common — that DTV was going to be a terrible disappointment and wouldn't work in any acceptable manner. Basically, they were wrong.

Many stations are finding that they are covering their cities of license better than they ever anticipated, operating at low power levels. DTV is turning out to work, and work well.

Back to low-power operation — one needs to realize that it isn't necesary to have an antenna weighing tons to have good electrical performance.

We seem to forget that the reason for having big, massive antennas is because of their mechanical strength, not necessarily their electrical performance. If we desire a high-power nondirectional top-mounted antenna, we need a physical structure that will survive a hostile environment while maintaining its electrical characteristics. You can't do that cheaply. However, you can side-mount a lightweight antenna, feed it with flexible cables and still get excellent performance at limited power.

With panel and other flex-line antenna types, the power divider sets the initial power limit. Remember, the goals here are performance and low cost. A small power divider coupled with 7/8- or 1-5/8-inch lines will handle input powers in the 5kW neighborhood. This can easily result in ERP values of 100kW or so, which will serve a good-sized area when coupled with reasonable height.

On the negative side, effective radiated power values of 1MW are not going to be possible. While the suits may not be interested in that level of power now, they might be once NTSC goes away and they realize that some stations in their market have more power than they do.

DTV is turning out to be robust, with service that works and works well.

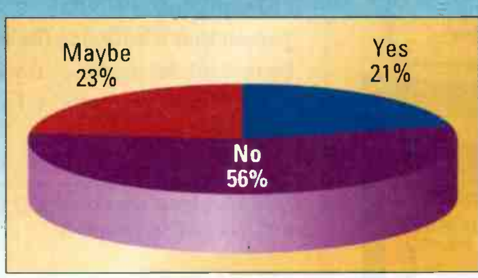
Also on the negative side, more maintenance will be required on these antennas. The flex lines are more susceptible to lightning damage than larger rigid lines. They also need to be inspected periodically to ensure that they are being properly supported to avoid damage from rubbing on tower members. This isn't a big deal — batwing antennas and panels have been in use for years, with lines running all over the place. It's just that they must be maintained, even in an era when management seems to think one technician is enough to handle five or six transmitting plants.

As to coverage, the FCC describes a manner of using F(50,50) curves to generate F(50,90) curves. The problem with this analysis is that it is based on the average terrain between two and 10 miles from the site, along however many radials are to be studied. The commission says to use 36 radials to determine city service. However, any interference calculations still must be based on the Technote 101 method,

FRAME GRAB A look at the consumer side of DTV

Watch out for snoops

Neighbors might peek at unprotected Wi-Fi networks



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commonly known as the Longley-Rice propagation model. Longley-Rice uses the actual terrain elevation along each radial all the way from the transmitter to the point where one wants to determine the field strength. This method is much more accurate in determining actual service than the older FCC curves. Unfortunately, it isn't a method that easily can be done with just the curves and a map. It requires massive number crunching.

To accurately determine signal strength using this method, you will need a reasonably fast computer, one of the many programs commercially available to run the study, and a database containing terrain elevations for

Broadcasters should remember that lightweight, low-power antennas require more maintenance. Photo courtesy Dielectric.

the area of concern. The least expensive programs are identified as 30-second files, which contain the elevation of the area or the whole country for every 30 seconds of latitude and longitude. The next move up is to a three-second database, which contains the elevations of the logical points.

Perhaps the simplest way to handle this is to go to either the station's consulting engineer or to one of the many services that will perform that calculation for you. If all that is required is a simple coverage map or study, the price should be a small fraction of the cost of acquiring the software and databases.

Most engineers will get their biggest surprise when they compare the service area and population covered between operation with 100kW ERP and 1000kW ERP. For something really eye-opening, calculate the cost per person that is added to the service area by that power increase. It will give you a whole new respect for peanut whistles. **BE**

Don Markley is president of D.L. Markley and Associates, Peoria, IL.

Send questions and comments to: don_markley@primediabusiness.com

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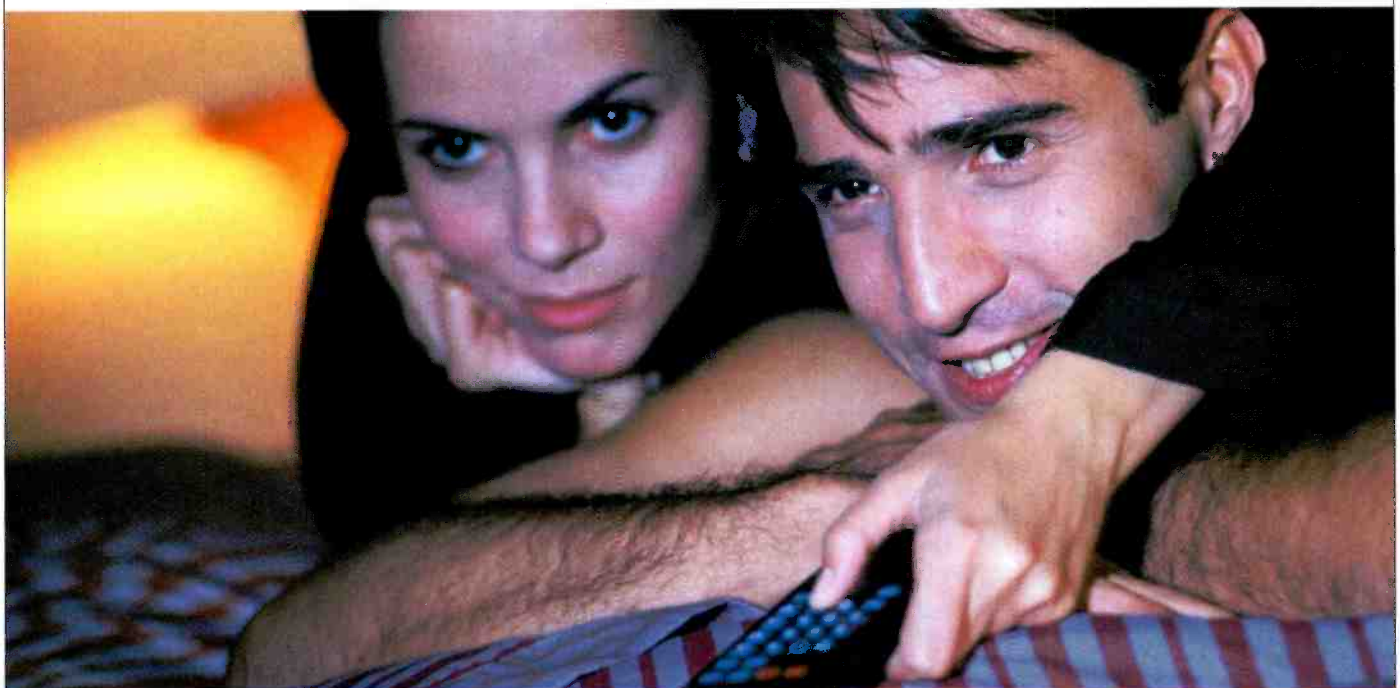

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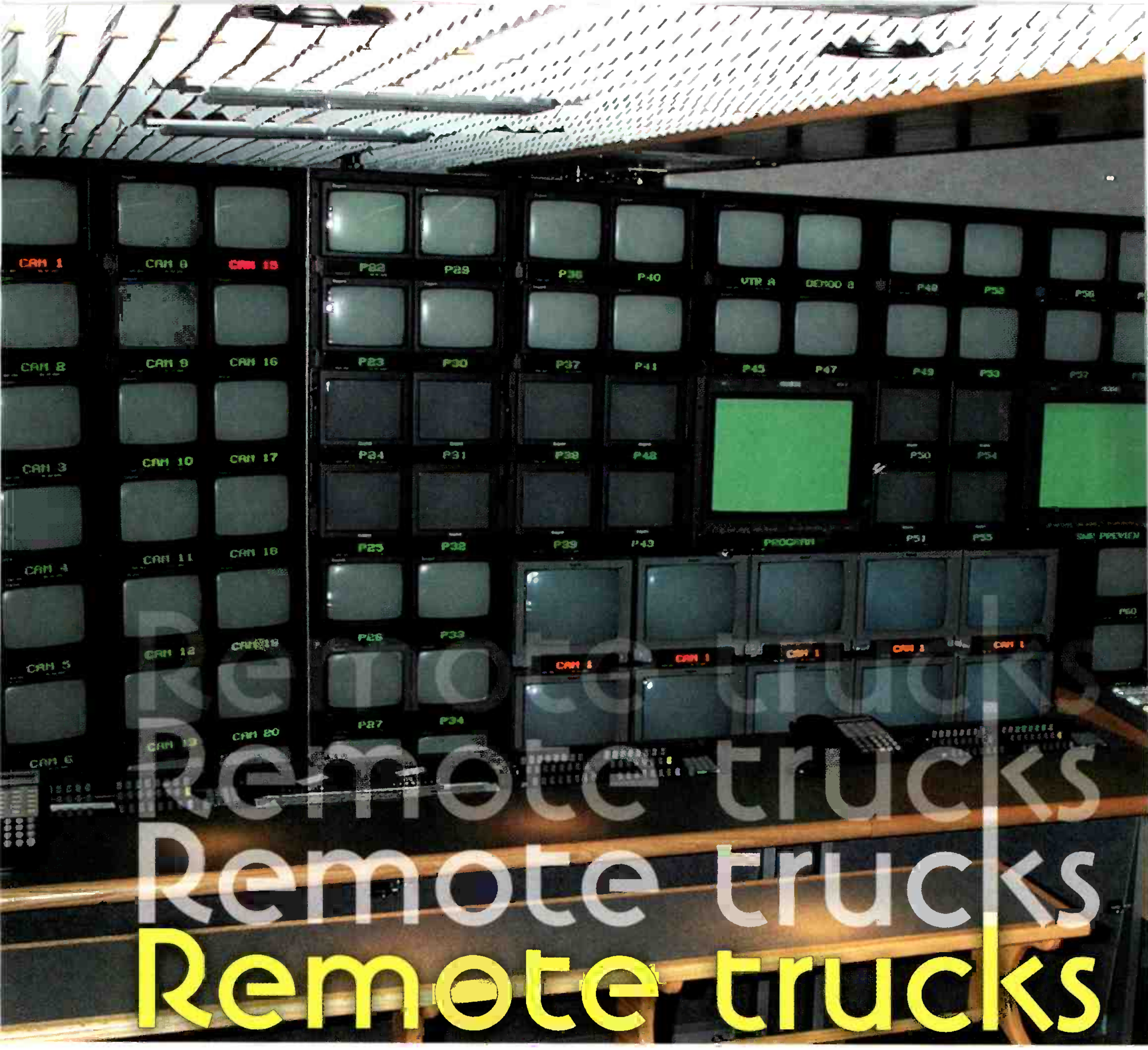


Remote trucks

Barry Bennett

This article attempts to outline some of the choices involved in building a truck today, both from a technical and a production perspective. The designer must consider all of the various methods of production and their implementation.

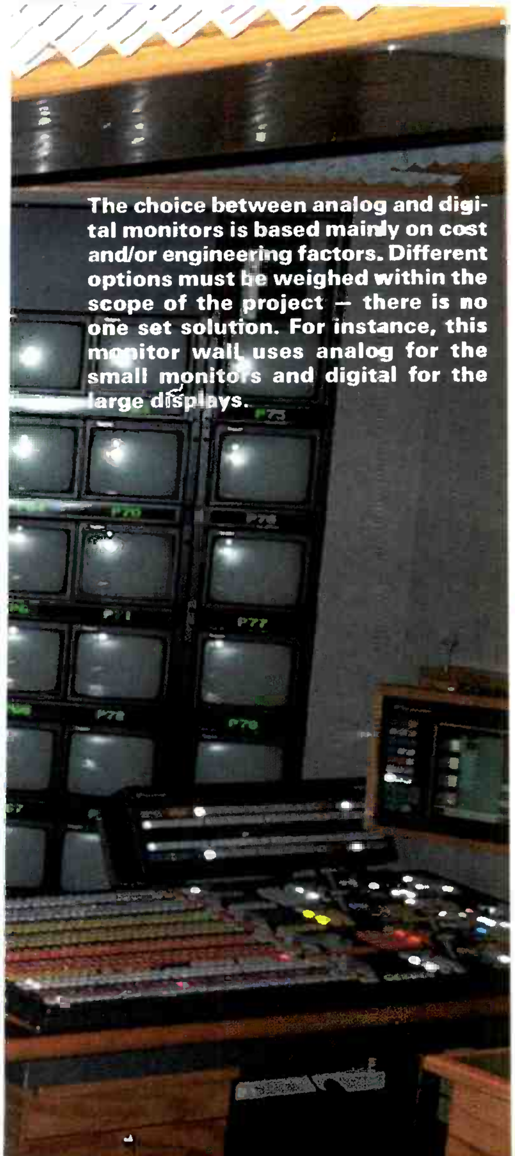
Each topic below could easily be the subject of its own magazine article. This limitation notwithstanding, the article attempts to point out, in general terms, the major items that must be evaluated before starting on a vehicle design.

The quandary

Building a remote broadcast truck today is an enormously challenging task. Recent advances in equipment design have made the actual system engineering more straightforward in some ways. But the question of just exactly what to build has become increasingly difficult. The choices and realities of format and aspect ratio, and today's economic considerations, have added several layers of complexity to the decision-making process.

It was not long ago that the main considerations in putting together a large-scale television truck were more or less limited to relatively simple decisions regarding specific equipment manufacturers. One simply needed to decide this camera vs. that camera, what brand switcher to use, what audio console, etc. Ok, maybe it wasn't so simple. It was, however, a lot more simple than the multitude of choices facing the truck builder today.

In the past, broadcasters could be fairly secure in assuming that their multimillion-dollar investment would enjoy a lifespan that would have a chance of retiring their investment



The choice between analog and digital monitors is based mainly on cost and/or engineering factors. Different options must be weighed within the scope of the project — there is no one set solution. For instance, this monitor wall uses analog for the small monitors and digital for the large displays.

debt. Now, not only is there extreme economic pressure, but technology that once would have remained viable for five years or seven years, or even longer, is no longer secure from rapid obsolescence.

Adding to the confusion are the aforementioned issues of format and aspect ratio, which include HD and SDI digital with all their various flavors, and analog NTSC for the immediate future and possibly even longer. New trucks must be multi-standard vehicles, requiring additional equipment to allow either simultaneous production in multiple formats, or the ability to switch between formats as clients' needs change.

Audio, while equally important as video to the production, at least presents fewer core technical choices at the moment. The main audio decisions will probably focus on analog vs. digital (in the remote truck world), and perhaps side issues such as surround sound and fader automation. The question of digital audio — where and how much to use it — is bound to arise. Even so, it is straightforward and relatively easy to answer.

There are other decisions that must be made during the initial design phase, including type of monitoring, tally display and intercom, as well as the physical details of layout, HVAC, and power and weight distribution.

The question of just exactly what to build has become increasingly difficult.

Perhaps the first, and arguably the most complex, step truck builders must take is to decide what video formats the truck must produce, and how to monitor them.

Truck eyes

Let's begin with the cameras, the "eyes" of the truck. Camera manufacturers have done an incredible job of creating cameras that can be easily switched among various formats and

The actual system engineering for a remote truck might be easier – thanks to advances in equipment design – but the complexity of format and aspect ratio makes deciding what to build in the first place a tougher question than ever.

aspect ratios. Some of them can even output multiple formats simultaneously. Keep in mind what the truck needs to produce. Is the end product to be NTSC analog, SDI digital or HD? Most likely, on any given day, it could be any of these.

An equally important issue is the type of camera cable the truck will employ. Thankfully, today's choices are limited to just fiber and triax. Fiber, while providing some potential advantages, is a lot more expensive to maintain and much more fragile than triax. It also suffers from the expensive disadvantage of not being pre-cabled into the majority of stadiums around the country. But, over time, the majority of venues around the country will likely install permanent fiber, as they did with triax many years ago.

The cameras chosen will need to be able to go either way, or at least be convertible at minimal cost and difficulty. Different camera manufacturers accomplish this in different ways, so be sure that you and your consultant evaluate each one against the specific needs of the project. It is also likely that the camera manufacturers will implement multiple-cable design at an attractive cost point, which will allow either type of cable to be used with little or no camera conversion.

Another decision is whether to have the camera output multiple formats right out of the CCU, and if simultaneous multiple formats are needed at all. A variety of "in the CCU" output solutions offer a bewildering array of options. And, of course, external conversion is also an option. The truck may end up with a mix of both. This decision will depend largely on the type of monitoring being used (discussed separately below).

If the truck must produce multiple formats simultaneously, the complexity can increase exponentially. One trend that may alleviate some of this complexity is that some end users may have started relaxing their requirements regarding output conversion. For example, it's theoretically possible to produce a show in HD/1080i or in HD/720p and convert the output to whatever the secondary standard may be — either the alternate HD format, SDI or even NTSC. In the case of NTSC, there are additional considerations such as graphics insertion and aspect ratio, which may require a compromise in camera framing in the HD show. While these are certainly critical production decisions, their technical implementation can be even more critical and sometimes bewildering, as well as costly. Fortunately, some, if not all, multi-standard cameras offer various monitoring options at the camera viewfinder, allowing camera operators to see the framing for both 4:3 and 16:9 simultaneously in most cases.

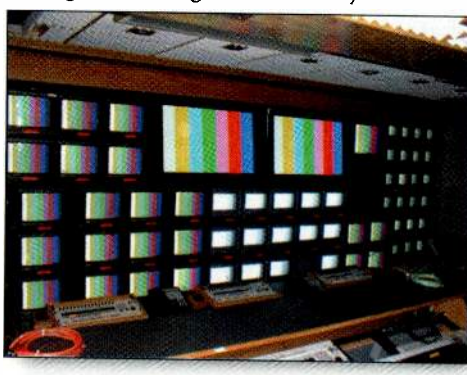
If the truck must produce multiple formats simultaneously, the complexity can increase exponentially.

Operator eyes

The production monitor wall is another excellent example of conflicting decisions facing a prospective truck owner today. Standard design would implement a tube-type monitor wall with 75 to 100 small black-and-white or color monitors and at least two 20-inch color monitors for program and preview. Today, there are additional choices and technical/production considerations that must be evaluated. Because this truck is, at some point in its life, going to be called upon to produce 16:9 shows, should the monitoring therefore be primarily 16:9? Should it be capable of 16:9 switching? If the truck owner is shooting a show in 16:9, and has clients that want a 4:3 show as well, a decision will need to be made as to the monitoring format. Perhaps a mix will be required. A 16:9 image on a 9-inch monitor can appear rather small. Broadcasters may wish to implement multiple monitor sizes in the main display wall.

Another possibility would be implementing one of the various "virtual" monitor walls available today. A side issue to monitoring is tally display. On-screen tally is necessary with any of the virtual monitor wall concepts. Otherwise, you must choose between the built-in tally light on the monitors, or an under-monitor display (UMD) system. A virtual monitor wall may have the added feature of providing essentially any display right on the wall itself, including operator names, or audio and video level meters.

Yet another decision in video monitoring is analog or digital. For all intents and purposes, this is a cost/engineering decision, because the difference in the picture quality (as viewed in the production room on the smaller monitors) is not sufficient to sway the decision. It is possible that, in the virtual monitor wall scheme, digital may have significant engineering advantages. It is also possible that, if the rest of the truck is digital, the addition of analog monitoring could add a layer of complexity and cost that could be offset by the use of digital monitoring. There is no one simple answer to this question. It must be evaluated within the entire design and production specification of the proposed vehicle.



Depending on the formats the truck supports, truck owners may decide a mix of analog, digital and HD monitoring is required. The large plasma displays here were fed HD signals.

Tape vs. disk

The tape room is another area of the truck that requires special attention. Today's usage still demands some standard tape formats, such as digital and analog Beta, and various flavors of disk-based recording. Sports production requires, at the very least, an EVS-type system, and sometimes more than one. This could be in addition to a Profile or other mass-storage device. The time is rapidly approaching when the entire "tape" room may migrate to a server-based system, regardless of the production format. This dictates that the core design of the truck be flexible enough to grow with the changing formats, or be upgradable with a minimum of fuss and expense. It is possible to implement a design that will allow for major future changes with a minimum of downtime and expense.

Nuts, bolts and wires

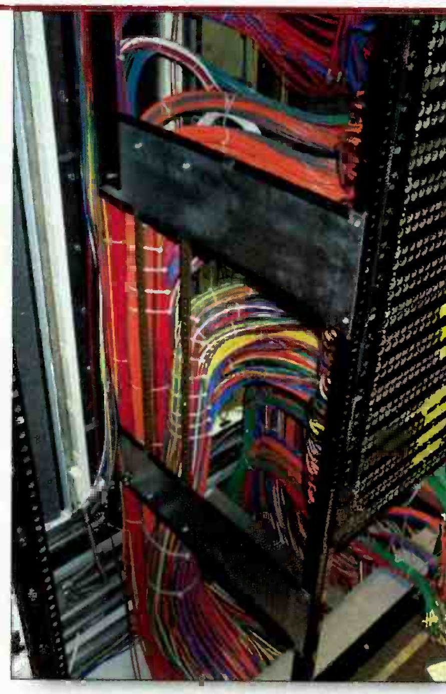
The actual physical construction of an HD/multiformat vehicle needs special attention also. The issues of production space, heat, overall weight, weight distribution, airflow and power are critical in a truck of this size and complexity.

Cabling in the high-data-rate world of high-definition video may need to be larger, and consequently heavier, than standard digital or analog cable. This larger cable takes up more space, and can lead to decreased airflow and potential heat problems if not implemented properly. The same holds true with digital audio cable — particularly if twisted pair is selected over coaxial. Careful system design specifications and integration practices can minimize the need for larger cable.

This can alleviate the inescapable airflow and weight issues, as smaller is better when installing wiring. Experienced systems integrators can put the correct cable where it is needed while minimizing the space it occupies. Overall weight must always be considered when engineering a large-scale truck. With proper engineering, up to 1000 pounds can be saved by careful cable selection alone. The cost of cable, and even system integration, diminishes rapidly when factored into the overall cost of the truck.

By selecting the proper system designer, you will enjoy savings in equipment (selecting the proper piece for the job) and gain long-term advantages such as simplifying daily operation, maintenance, and future changes and upgrades.

Generally speaking, digital production equipment may be expected to produce more heat, in roughly the same space, than the analog equivalent. So, airflow and overall cooling capacity, as well as AC power considerations, will need to be carefully designed and specified. Choosing a virtual monitor wall instead of a CRT monitor will further save weight, space and power.



Careful cable choice and neat installation can help alleviate airflow and weight issues in truck construction.

As a prospective truck owner today, you face a bewildering array of choices in production equipment. And you must make these choices before the first walls and wires are put into the CAD drawings. The issues are complex and interrelated as never before in our industry. But careful design specifications in the planning stages will lead to a truck that can handle the various formats necessary in production today, and well into the ever-changing future. **BE**

Barry Bennett is the owner of Bennett Systems, a firm providing systems consultation, engineering and integration.

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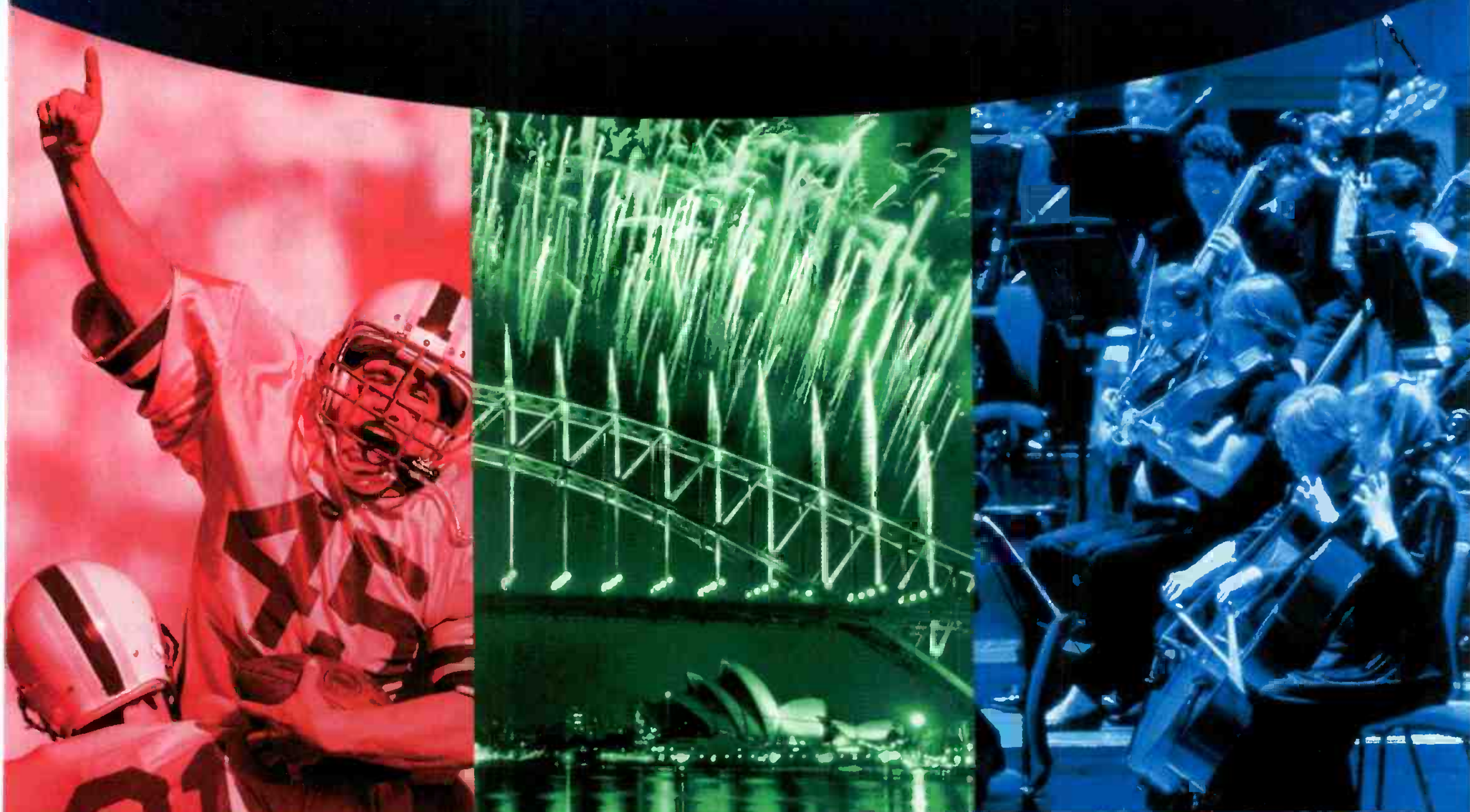

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Multichannel broadcasting

BY JIM BOSTON AND MARK BROWN

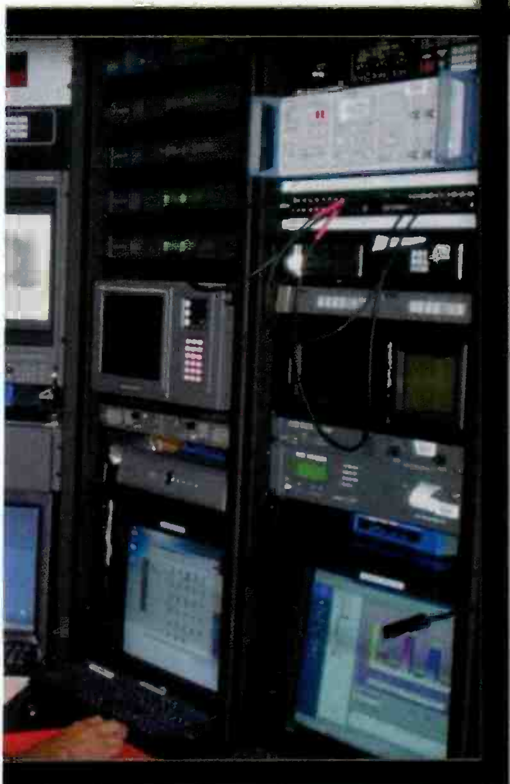
Local stations' migration from providers of a single NTSC over-the-air service to that of multiple ATSC services is slowly gaining speed. To the broadcast community, this migration has moved beyond a mandate to a matter of downright survival. Most broadcasters, especially commercial broadcasters, began with the minimal required DTV services. By contrast, PBS stations have received additional funding to deploy leading-edge projects, and some have gone beyond the base FCC requirements and experimented with ATSC's potential — offering multiple services from the beginning. These stations understand the business potential additional services can offer. Conversely, commercial broadcasters, as a rule, have looked upon DTV as an added burden that brought much to the expenses column and thus simply subtracted from the bottom line.

However, commercial broadcasters are now starting to realize that in just a few more years, DTV and supporting services may be all that they have to offer. The time is approaching when broadcasters will have to start thinking about how to craft their DTV infrastructure in order to garner a return on their massive digital investment. The revenue pie continues to shrink, and the competition for eyeballs increases. Many are now realizing that there might be far fewer stations in 10 years than the nearly 1600 stations in the United States currently. Even in the large markets, general managers are wondering if more than three competing newscasts can remain viable. Local and national advertisers are finding new and creative ways of getting exposure via alternative program and cable operators. According to a recent study by Marian Azzaro, professor of marketing at Roosevelt University in Chicago, advertisers would need to buy 42 percent more commercial inventory on the three major networks than they did 10 years ago just to reach the same size audience today. It's not just competition with cable programmers; other media, including the Internet and the video game industry, are also siphoning off viewers. In fact, the video gaming industry is a $28 billion dollar force that now rakes in more revenue than all commercial television in this country.

Revenue generation

Within the last year, HD has emerged as one of television's potential "killer apps." A number of

For some broadcasters, multichannel is the next step in their digital evolution. KCSM-DT in San Mateo, CA (bottom left), broadcasts one HD and two SD channels; KTXT-DT in Lubbock, TX (center), broadcasts four SD channels along with its HD channel; and KLVX-DT (top right) delivers a mix of one HD and three SD channels, along with 12 channels of instructional television services, to its Las Vegas, NV, viewers. Photos courtesy SignaSys.



elements have aligned to make this technology finally gel for content providers, distributors and consumers. On the content side, cameras were introduced that were native in both 720p and in 1080i. This allows remote trucks — programming and production vendors to the networks — to invest in HD equipment, as they no longer have to invest in two types of cameras or expensive conversion equipment to serve the separate ABC/ESPN/FOX and CBS/NBC/PBS HD camps. Secondly, HD equipment has dropped enough in price that there is a chance of making the investment pay off sooner, rather than later. On the distribution side, ABC, CBS and NBC are now offering all prime time programming in HD. In addition, ESPN is investing $200 million in a large HD production facility in Bristol, CT, and has plans to produce 3700 hours of HD content annually starting in 2004.

Getting back to the option presented by multichannel, many of the major networks are considering or implementing plans to provide multiple program streams to the affiliates. Here again, PBS is leading the way — with PBS-HD, PBS-Kids and PBS-You.

Implementing multichannel

Many local broadcasters are waking up to the fact that the first station in a market to put up a local repurposed news wheel, or extended news coverage on a secondary channel, stands a much better chance of survival than the third or fourth to follow suit. The cost of adding multiple program services to a DTV transport stream is low compared to initial DTV start-up costs, typically 10 percent per additional channel. If a multichannel operation is implemented correctly, the recurring operational cost impact is also low — it typically requires the same level of human resources as a single-channel operation.

A benefit of multichannel operation is that it allows for cross-market penetration. If your newscast is to be cannibalized by someone, you might as well do it — thus conserving your views and advertising revenue.

Let's define the term "multicasting" as multichannel ATSC broadcasting that

The cost of adding multiple program services to a DTV transport stream is low compared to initial DTV start-up costs.

effectively and efficiently manages and integrates several services.

Figure 1 on page 58 illustrates an ATSC multichannel environment. There are a number of considerations involved in the deployment of a multichannel facility. Additional services do not necessarily require more staff, but often do require changes in operational duties. Therefore, workflow and other operational impacts will have to be considered. Changes to infrastructure also need to be considered carefully — including the topology, redundancy, failover capabilities and fault isolation required to successfully apply the technology to meet your station's business goals.

An important aspect of multichannel operation is that the application processes involved need to be more collaborative and cohesive. Automation, typically driven from traffic, now must control ATSC encoder/muxing elements to change their service profiles (i.e. encoder status and limits, bandwidth to service allocation, etc.). Multiple traffic logs and dynamic PSIP tables must also be kept in coordination so that programming reflects information contained in appropriate PSIP text tables. This coordination can become cumbersome with certain types of live programming, such as sporting events that don't run their scheduled length.

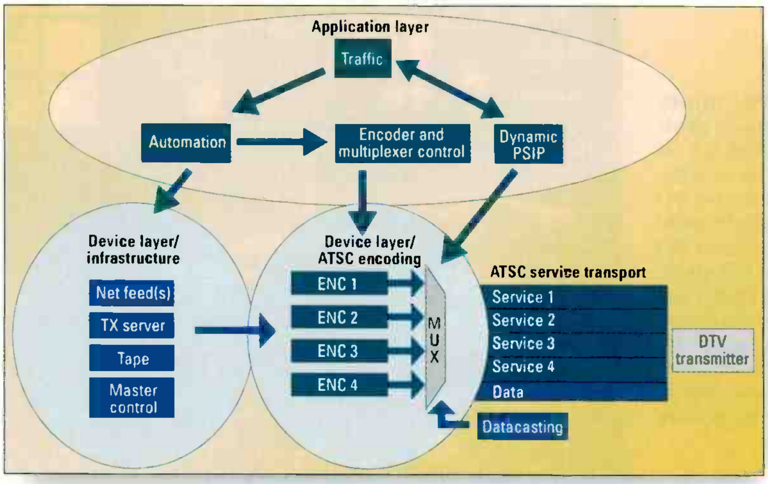


Figure 1. In multichannel operations, the application layer gets larger and more processes must collaborate to effectively manage the additional services.

Making the switch

As Figure 2 depicts, television stations commonly follow a three-phase migration path when converting from single-channel NTSC to full-service ATSC. Most stations have undergone the first phase of the evolution — the air phase. This entails nothing more than updating the necessary transmission food chain and encoder/mux, some simple ATSC monitoring at master control, and some acquisition equipment to pass through their network's digital feed. Some large-market stations have also undergone the second phase — the plant phase. Here the migration to "digital" is extended through the rest of the plant's infrastructure, including extended switching and enhanced branding. The third phase — the enhancement phase — is the final leap into the full possibilities of ATSC. Here additional channels, along with HD production and datacasting, might be thrown into the mix.

A number of new issues arise with the implementation of additional channels,

Air phase	Plant phase	Enhancement phase
Transmission	Enhanced traffic	Datacasting
Encoder/multiplexer	Multichannel automation	Archive and asset management
Simple master control monitoring	Infrastructure - Multiformat routing - Central server - Conversion and distribution - Tape	Production
Acquisition	Master control - Enhanced monitoring and control	Additional channels
	Facility enhancements	

Figure 2. Most stations have completed the air phase of the transition to DTV. Some larger stations have also completed the plant phase — converting the rest of their operations to digital.

including how to handle EAS and closed captioning (see Figure 3 for a typical multichannel conceptual). First, the FCC requires that all major ATSC program services carry required emergency alerts. So the infrastructure to insert the alert needs to be in place for each program, even if additional program streams are simply a "pass-through," or a series of clips from a server. Usually the same device that handles that chore also inserts logos and, potentially, enhanced branding.

problem with most SD streams, because closed captioning information is still carried along in the vertical interval or ancillary data space. But there is no standard for doing the same thing in HD. Although there is a standard for embedding serial data into the ancillary data space of a SMPTE 292 stream (SMPTE 334), it is not closed captioning-specific, and not all encoders support extracting the data. Plus, the standards for baseband captioning are different: EIA-608 for SD (SMPTE-59)

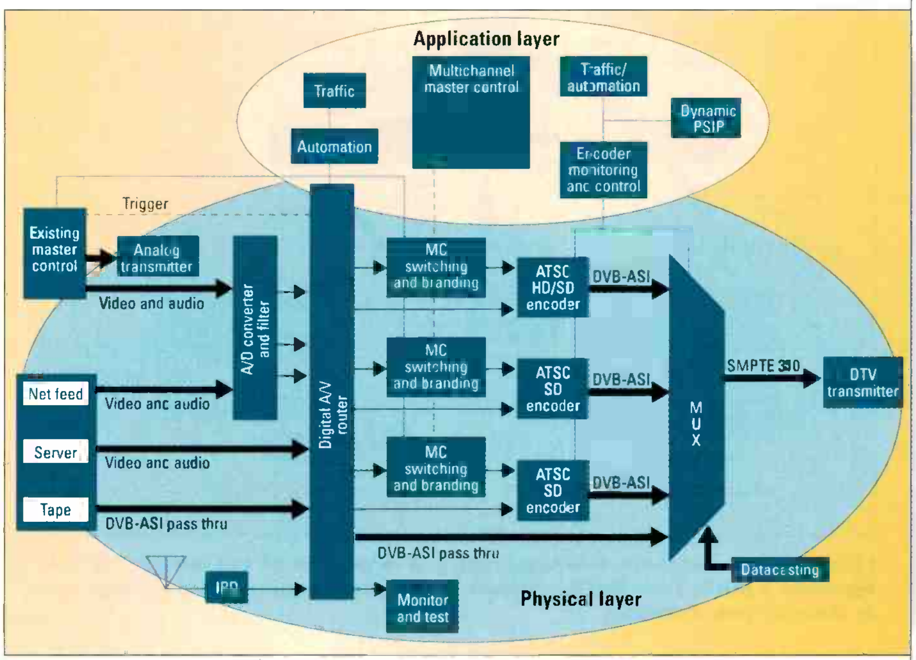


Figure 3. In this conceptual drawing of a multichannel operation, the left side of the physical layer shows legacy infrastructure, while the right side shows the ATSC food chain necessary to support multiple feeds. The dotted lines show interaction between master control and switching and branding, and routing functions.

Seldom do these additional channels have their own master control infrastructure. Some multichannel facilities drop only a single instance of a master control switcher into a specific program path that requires transitions more complex than a simple cut; otherwise a router crosspoint is used to select sources. Other approaches include integrating switching and possibly branding in each program path to embellish the content's look and feel.

Closed captioning is another implementation issue facing local multichannel providers. This is typically not a

at 960 baud, and EIA-708 for HD at 9600 baud. There are devices that extract closed captioning from an SD signal and embed the resulting EIA-608 data into an EIA-708 data field, this is commonly done in new encoders. The resulting data can also be interfaced to the ATSC encoder.

Soon additional issues will face the broadcaster, including the Broadcast Flag, and audio metadata issues such as dial norm and Dynamic Range Control (DRC). Newly deployed multichannel systems should take these issues into consideration.

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Multichannel broadcasting presents a considerable change in master control operators' primary duties. A master control operator's job migrates from switching feeds to air to keeping a system on air. Under these new requirements, operators will primarily react to systemic faults, rather than actively switch between sources. They react to changes that have occurred in one program log that will need to ripple across other logs. (See Figure 4.) Monitoring multiple programs' health can consume a fair amount of the operator's time.

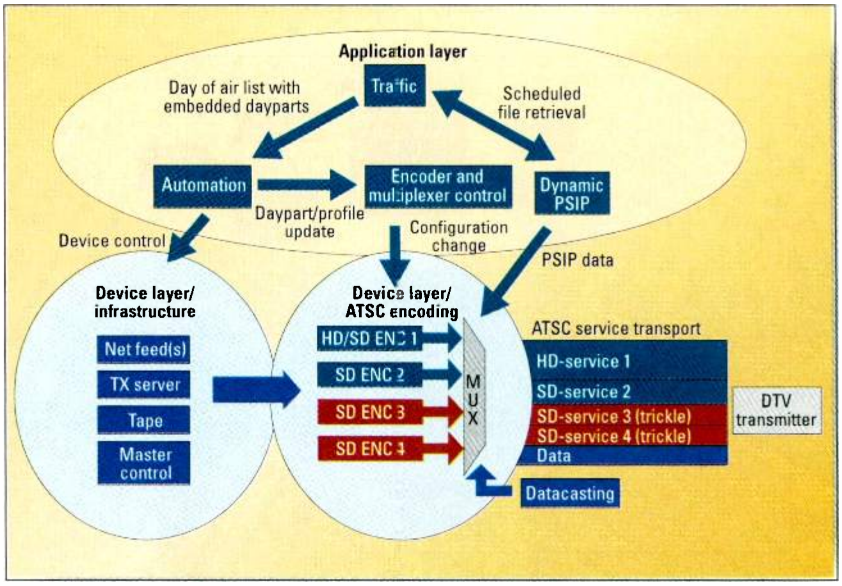
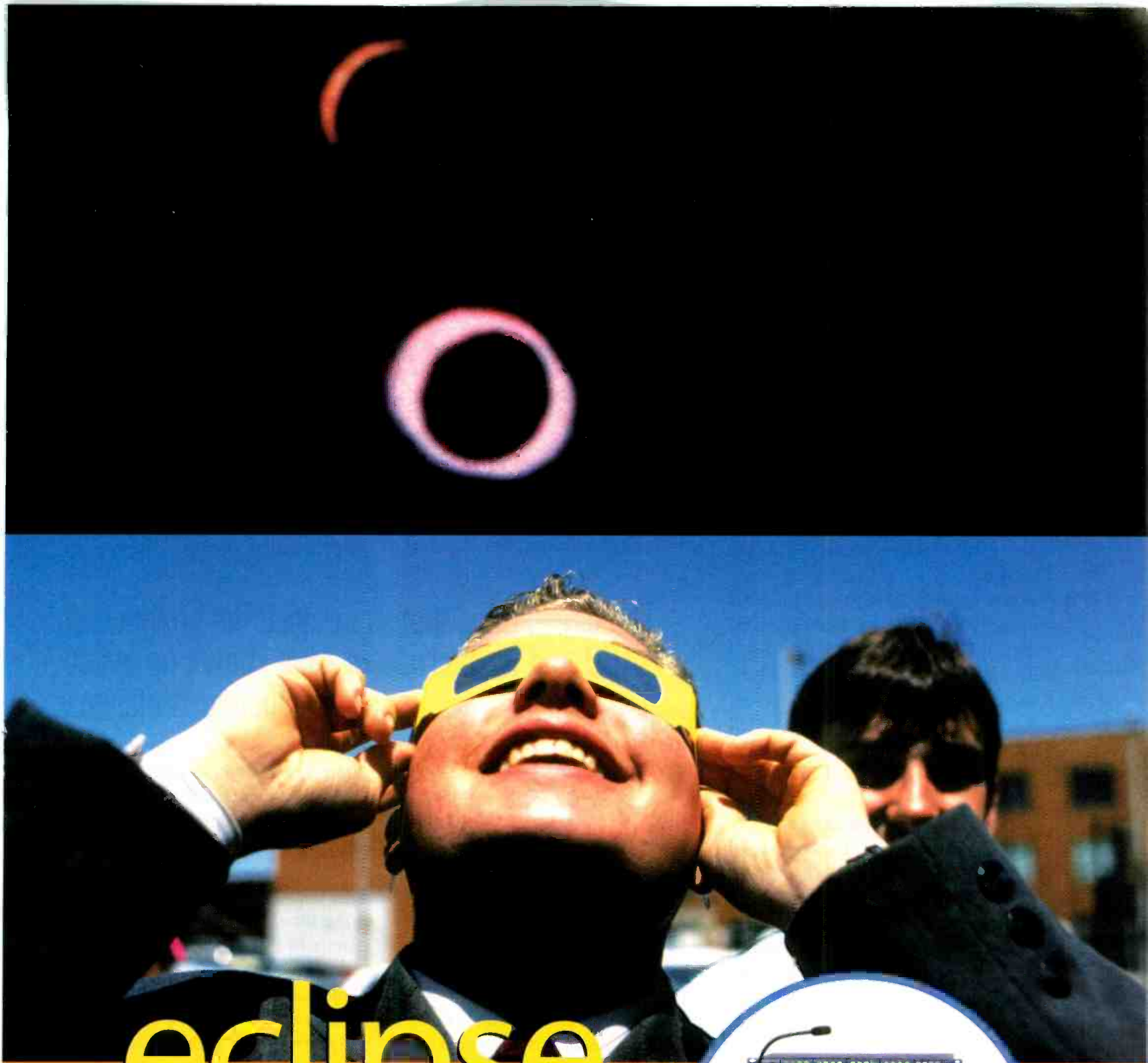


Figure 4. In multichannel broadcasting, a large part of the master control operator's job is reacting to system faults, and keeping program logs up-to-date across channels.

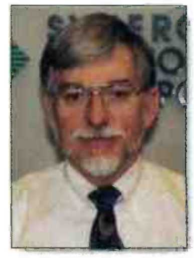
In support of fault isolation, multi-image displays with integrated alarming and status elements will be needed to aid the operator in isolating subsystem faults and returning programming to air. In addition, more sophisticated methods of automatically trapping system faults are now available. These include integrated stream probes that monitor signal status and, as necessary, provide alarming information along the entire signal path via a visual display. These probes allow an operator to see streaming thumbnails of actual video and audio information, which can be displayed on an HTML Web page as a simple system concept, or even on a multi-image display wall. Because this approach uses Web-based technologies, remote personnel can also gain access and monitor system status. In addition, broadcasters are employing a slew of generic and more television-specific SNMP applications, long used by the telcos to spot problems across far-flung networks. SNMP applications allow for simple checks such as for video continuity; active video presence; EDH errors; audio discrepancies, including volume, phase and balance; and metadata problems such as with closed captioning and PSIP.

In multichannel infrastructures, the human and software processes that comprise the application layer need to work much more collaboratively. This collaboration, rather than the signal flow, defines workflow in today's station. Implementing a workflow-based multichannel operation will enable broadcasters to benefit by delivering a broader range of services more effectively. **BE**

Jim Boston is senior director of technology, and Mark Brown is CTO, for SignaSys.



Graphics and effects technology



BY JOHN LUFF

Digital video effects were first introduced to the broadcast marketplace in the early 1970s. The first commercial unit was the Vital Industries Squeezoom. It had up to four channels of video and could perform the type of scaling functions that we see on our computer screens every day. Squeezoom was the first digital video-effects unit available. It was followed by the NEC Mark I and Mark II DVEs, which Thomson Grass Valley marketed with its line of production switchers. Joining these were Abekas, Ampex, Quantel, Sony and others, all of which built hardware-processing devices to produce digital effects.

Processing progress

At the same time, some companies were putting research efforts into generic image-processing engines. Abekas, Thomson Grass Valley and others pursued this market and eventually built digital video switchers that used image-effects processing. But the device everyone sought was a general-purpose computing platform that could manipulate image data in real time. There were predictions that the days of the special-purpose box, i.e. video switchers and DVEs, were numbered, and that HP, SGI, Sun and others would own the broadcast space in a matter of years.

Until recently, general-purpose computers weren't powerful enough to make complex image transformations in real time. Even today, much of the complex processing is offloaded to processing engines tuned specifically for that purpose. We can expect that software will be able to run at sufficient speed to accomplish most, if not all, effects processing for standard-definition pictures in the coming years. HDTV processing probably will lag some years behind, because the amount of data that must be processed to generate complex effects in HD is simply too large.

Processing update

The more we expect, the more we seem to drive the creative engineering community to develop more complex and capable solutions. Computing platforms have taken the lead position for some applications, especially those where the work can be done offline outside of live production. In those instances, rendering time is not an issue, and pre- or post-production techniques are most appropriate.

Live mattes and DVEs

Sophisticated mattes and DVE moves must be created online for live sports and news, and for high-profile productions of major entertainment events (Emmys, Oscars, etc.). This requirement has grown in sophistication, and has encouraged the manufacturers of digital production switchers to include increasingly complex effects capability in tightly integrated, or internal, DVE channels. Pinnacle, Ross, Sony, Thomson Grass Valley and others all have built multiple-channel DVEs into current production switchers. Some have a limited range of capability. But, increasingly, the capabilities that were once the province of ADO and its successors have shown up inside production switchers. And there is every reason to expect this trend to continue.

The capabilities that were once the province of ADO and its successors have shown up inside production switchers.

Live graphics

Graphics, in many respects, are a different matter. Pre-canned graphics elements that appear to be created live can be played live in productions. Consider the head shots used in sports. They are obviously pre-produced, but their live insertion is a critical production element. These capabilities are well supported by special-purpose computing platforms, often with graphics engines under software I/O and user-interface control. Triggering them from production switchers is commonplace. For sports, it is common to have the official time and score delivered to the graphics engine in real time, allowing complex presentations to be made on-the-fly using templates created in advance.

For decades, this technique has been used for election-night graphics; now it has moved into the mainstream. Graphics-intensive computers have adapted quite well to these special-purpose needs. An example is the use of "first and ten" graphics inserted live at sports venues. The computation is complex. Data from the camera(s) on pan, tilt and zoom is fed to a computer that calculates a 3-D representation in real time and provides key signals to either an internal or external keyer. These capabilities are closely related to virtual sets and are extensible to a wide range of future uses. **BE**

John Luff is senior vice president of business development for AZCAR.

SEND Send questions and comments to: john_luff@primediabusiness.com

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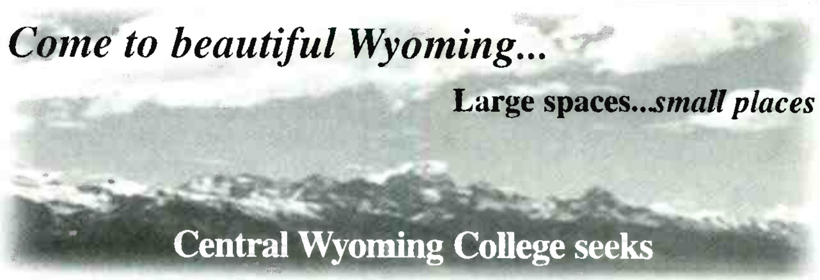

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Attention, broadcast shoppers

BY PAUL MCGOLDRICK

Everything has a price and, generally speaking, in our technology world the price reduces fairly consistently over the duration of time that the product has been released. Entering 2004 we now have the $29.95 DVD player, while DVD recorders are reaching price levels where they are going to threaten the VHS machine.

Yet, some consumer items never seem to come down in price: When did you last see a replacement model car be cheaper? And some prices increase for reasons that can only be defined as silly.

Cable advertises that satellite dishes are useless because the subscribers lose pictures in all kinds of weather. Living at about 45 degrees latitude with a winter climate where the rain is driven horizontally at rates that sometimes reach two inches per hour, I feel I represent a good test bed for the satellite companies' systems. In about six years, I have seen the weather take the picture out maybe twice — and that was with hail the size of golf balls coming down.

I'm probably not the average installation. The site selection for the dish is away from the worst winds with a coaxial cable run of less than 12 feet, and all the connectors are properly attached. It's also a little unusual because I do have a lightning rod connection in the cable run. I've seen what lightning can do at a broadcast installation. Still, I would hope that the professional installers that the satellite companies use are at least reasonably clued in on the basics. At my location, the choice is between cable and satellite; the only receivable terrestrial stations are two low-power transposers, both diplexed into a common antenna with one operating at 1W peak video. The local cable company is a joke, with the feed to my house actually spliced in the street. You can get good reception just by pointing an antenna at the nearest cable box, because they have continually pumped up the levels at the headend so they can expand the system without adding line amplifiers.

At a time when the satellite providers are hitting heavy with special offers and providing more and more local channels — albeit at the cost of bit rates on some other channels — where should the cable providers be spending their promotional money? What message should they be sending to persuade the average user that cable is better? How about by increasing their prices?

Comcast decided to usher in the new year in at least one market with increases of about 5 percent across the board.

Yes, at a time when they are fighting for every possible viewer, when their competition is flaying the market with advertising and special offers, at least one of the cable companies, Comcast, decided to usher in the new year in at least one market with increases of about 5 percent across the board. There is a serious disconnect somewhere here, and I don't believe it is at my end of things. For the 40 odd dollars a month that my family spends to bring a 100-channel package, plus networks, plus the "SuperStations," you now can have "standard cable" in the Portland, OR, metropolitan area.

Go digital with Comcast — and the satellite companies aren't pushing the "We're already digital" message nearly hard enough — and you can spend up to $95 a month before adding $35 for broadband, from a company that sends threatening letters to about one percent of its customers, telling them that they will suspend Internet service; the one percent, Comcast says, uses 28 percent of the company's bandwidth.

This is going to be a spectacular year for the broadcast industry. We have presidential elections and the summer Olympic Games out of Athens, Greece. And in a recent visit at a large transmitter manufacturer, it seemed clear that engineering money is available too. With the FCC cut-off year of 2006 looming closer, although unlikely to be held firm by the commission, there are a lot of full-power transmitter orders expected to be placed. Between the election advertising and advertising placed both during the Olympics' coverage and the competing channels' programs, engineering is going to get its much deserved share.

This makes the disconnect between services and hardware even more dramatic. Comcast believes that there is no consumer cut-off point for programming charges, and that is reflected in what they think they can charge for hardware. There may be $29.95 DVD players out there, but they think they can charge up to $450 for a non-returned set-top box. Everything does have a price. **BE**

Paul McGoldrick is an industry consultant based on the West Coast.

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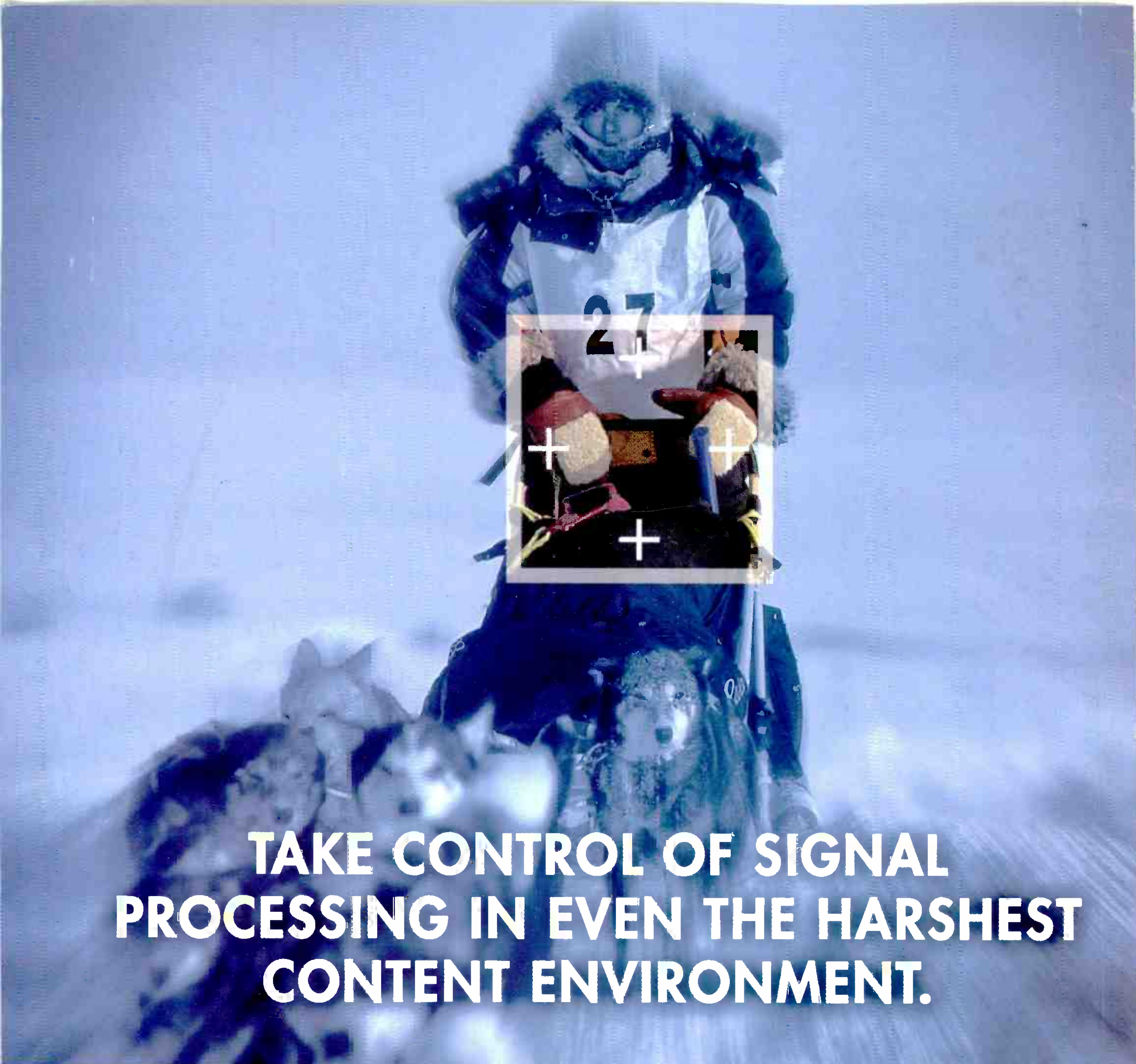

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