BROADCAST engineering

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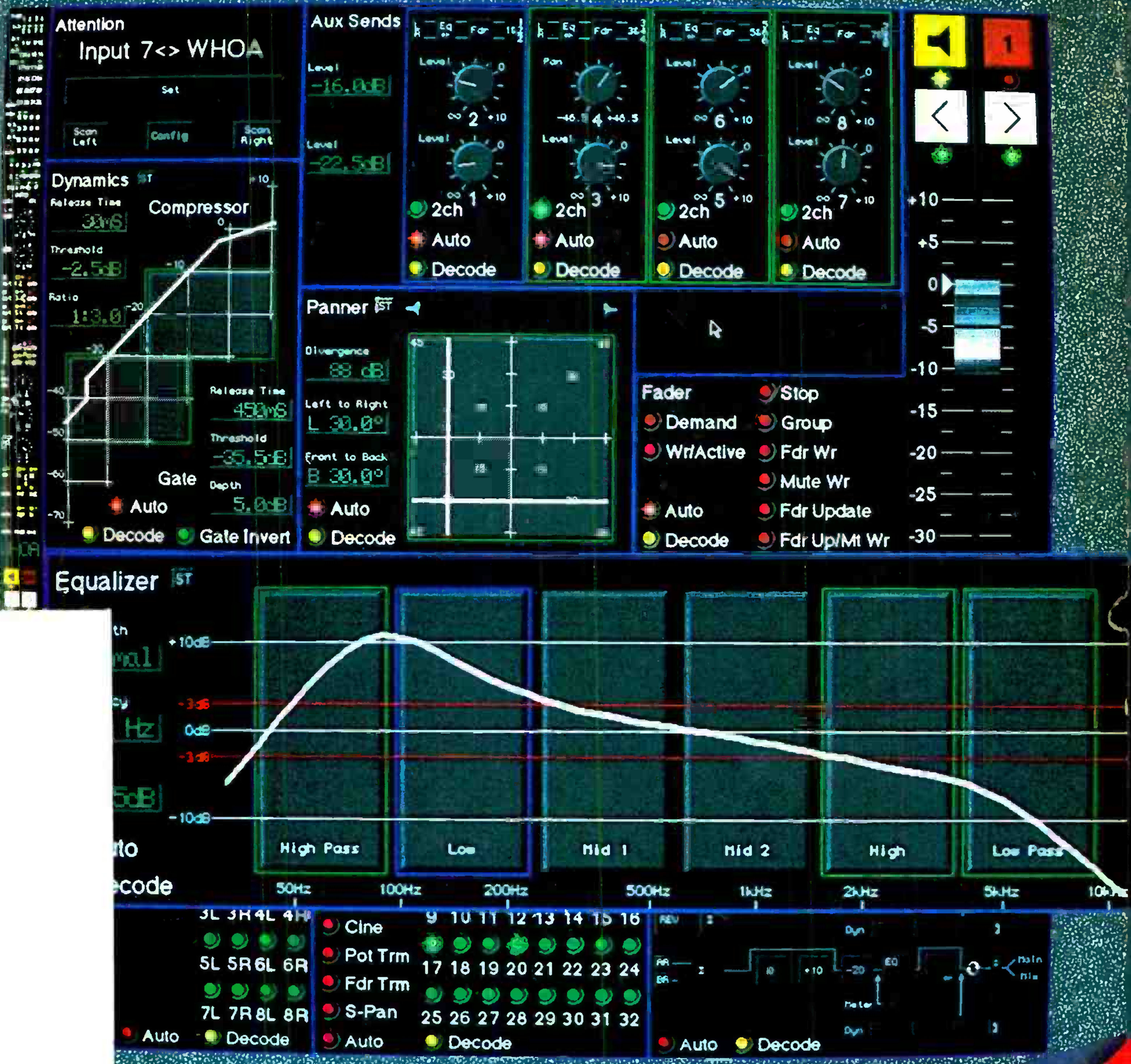
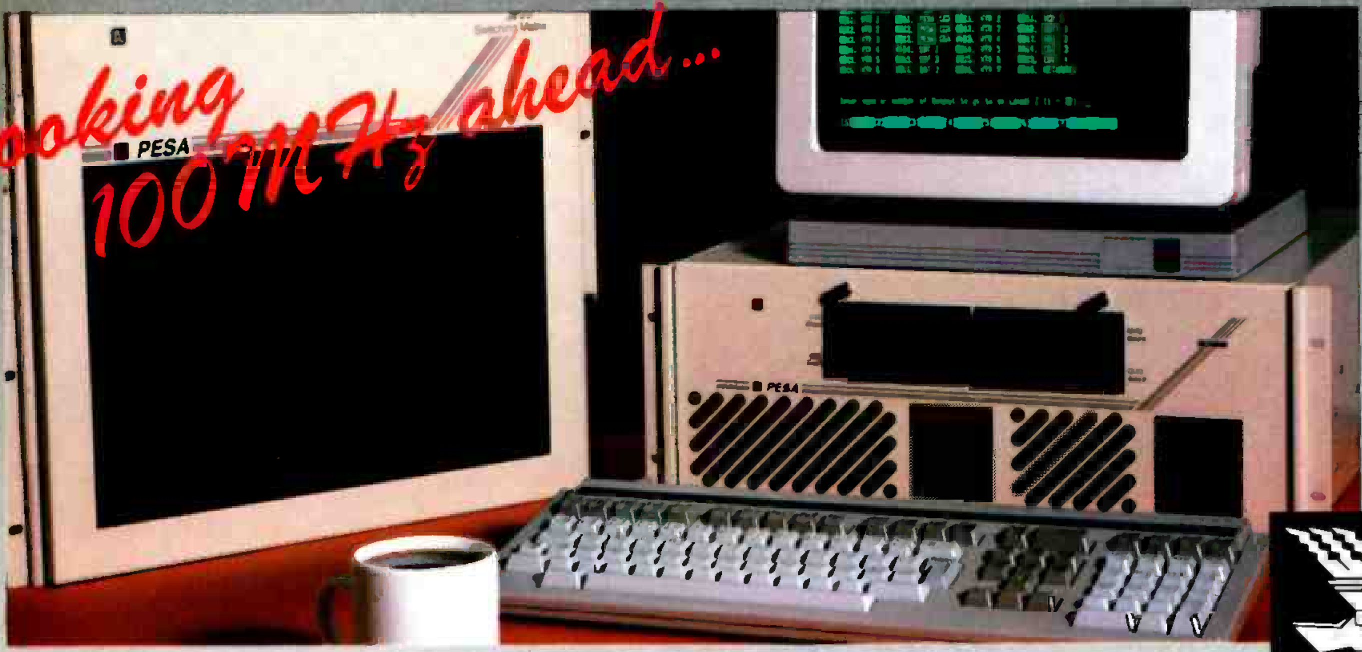


Audio-video control systems

SBE Show Preview p. 92



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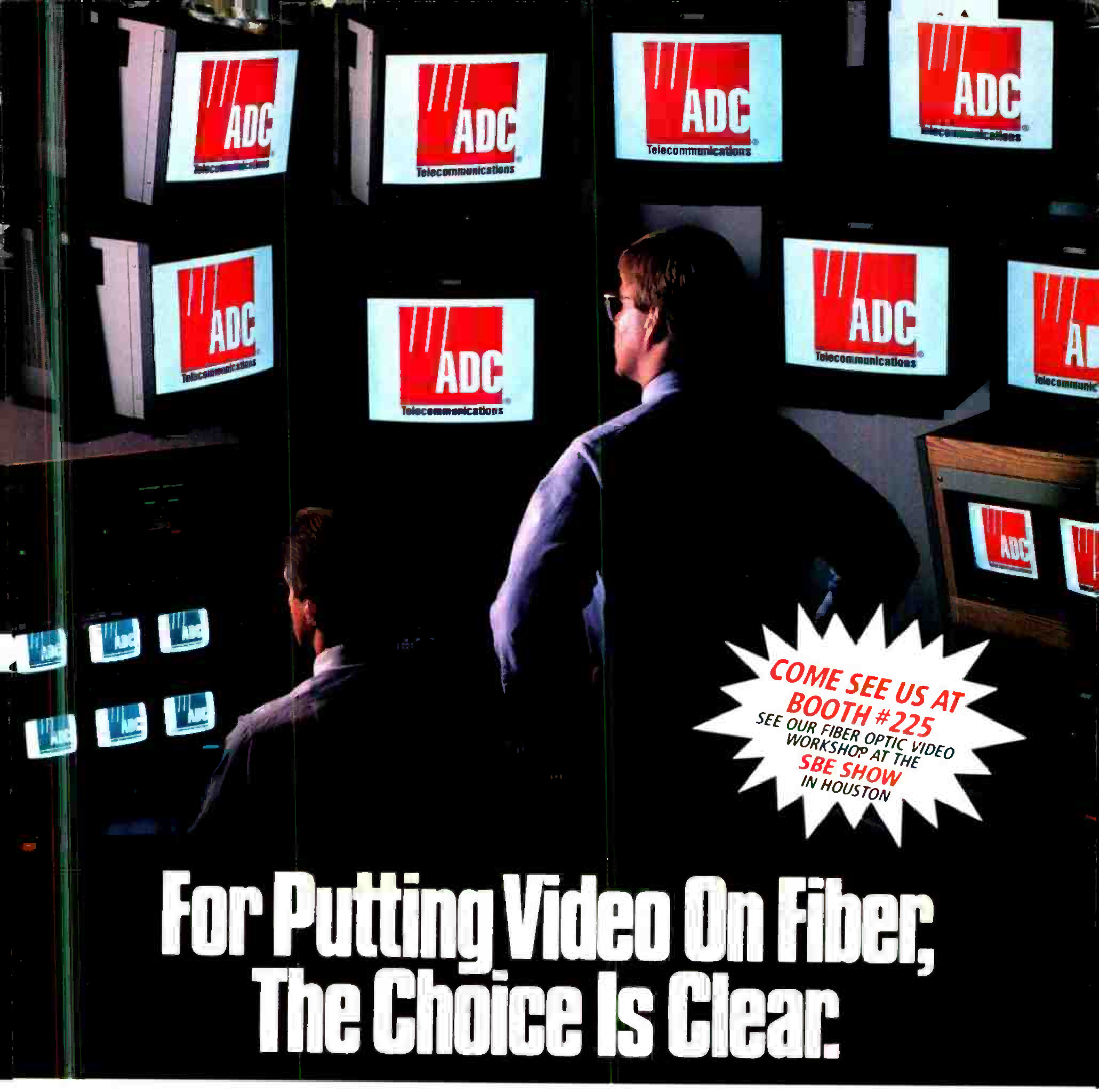

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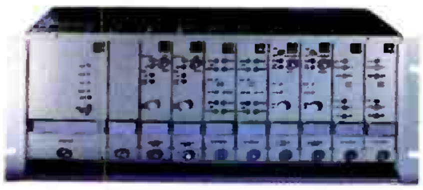

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AUDIO-VIDEO CONTROL SYSTEMS:

Modern control and production rooms are complex. With automation, digital and higher-quality signals widely available, technology managers are provided with opportunity and challenge. Those who learn to take advantage of these new evolving ideas will help lead their stations and production facilities toward a profitable future.

DEPARTMENTS

ON THE COVER

Illustrated on the cover is the screen display of a modern audio console, which uses digital technology to provide easy access to the system's configuration and operation. (Cover credit: Kim Bracken, *BE* graphic designer. Console screen display by Harrison/GLW.)

FEATURES:

OTHER FEATURES:

ANOTHER BURLE POWER TUBE HAPPY BIRTHDAY!

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News

By Dawn Hightower,
senior associate editor

Advanced TV testing begins

The official testing of advanced TV transmission systems vying to become the new high-definition TV broadcast standard started with the click of a computer key by Alfred C. Sikes, chairman of the Federal Communications Committee (FCC).

This activated the special test apparatus that has been under development for approximately three years.

The event marked the beginning of a planned year-long testing effort at the Advanced Television Test Center (ATTC). The goal is to help the FCC set the new standard by June 1993.

In a special arrangement between ATTC and Cable Television Laboratories, the cable industry will simultaneously be testing these ATV systems for cable use, using additional purpose-built equipment.

Six ATV systems proposed by a number of different organizations are scheduled for testing. The FCC Advisory Committee has certified each as warranting testing. One system (ACTV) is an enhanced-definition television (EDTV), which proposes to build on today's (NTSC) TV system. Five systems are simulcast HDTV, which propose to operate independent of today's services and on now-vacant TV channels. Of these five systems, all use digital signal processing. However, one would transmit TV signals in analog form (Narrow-MUSE), and four would do so in digital form.

The proponent of each ATV system must deliver and maintain a full TV transmission system — video and audio — operating in real time, with no simulations.

The laboratory testing of each ATV system will take approximately seven weeks, and will result in technical objective measurements about the performance of each system under controlled lab conditions.

Increased security for ENG operations

The FCC has amended its rules to permit the use of digital voice ("F3Y") emission for encrypting aural communications of remote pickup broadcast stations. This will enable licensees to prevent unauthorized interception and use by third parties of intrastation communications related to newsgathering and program production.

This change was prompted by the commission's receipt of several applications for authorization to use F3Y emission in the Remote Pickup Broadcast Service. The applicants wanted to keep communications relating to news reporting confidential until the stories could be aired. Broadcasters maintained that although third-party reception and use of such radio signals was prohibited, the aggressive competition among news crews to be first with an exclusive news story sometimes made the extra level afforded by digital encryption technology necessary.

In a departure from the rulemaking notice, the commission will allow stations using F3Y emission to transmit unscrambled analog or international Morse Code station identification at intervals not exceeding 15 minutes during operation, preferably using the broadcast station's Part 73 call sign. This will enable any party receiving interference to easily identify the source.

October date set for Technical Conference

The Society of Motion Picture and Television Engineers (SMPTE) has scheduled its 133rd Technical Conference and Equipment Exhibit, Oct. 26-29 in the Los Angeles Convention Center, Los Angeles.

There will be technical programs, equipment exhibits, seminars, workshops and a student fair.

Congressman Ritter to speak at SBE Convention

The SBE banquet that will be held during the SBE Convention, Oct. 3-6, in Houston will feature U.S. Congressman Don Ritter. He is currently serving his seventh term in the U.S. House of Representatives, and represents Pennsylvania's 15th Congressional District.

He is only one of a handful of 435 members of the House with a technological background, and the only one at a doctoral level. Ritter earned his master's and doctor of science degrees from the Massachusetts Institute of Technology, and his bachelor of science degree from Lehigh University, Bethlehem, PA.

BE

BROADCAST engineering

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INTERTEC PUBLISHING CORPORATION

Circle (6) on Reply Card

Never mind that the sky is falling

Sometimes we're our own worst enemy. I believe that's the case with many station general managers and owners. They mistakenly believe that if technical problems are ignored, or ones they aren't aware of, will simply go away. Nothing could be further from the truth. Technical problems that are ignored could be ones that end up costing you m-o-n-e-y.

This summer, I spent a lot of time traveling. Combined with business travel, vacation and my daily 70-mile commute, I spent a lot of time listening to my car radio. Recently, I was able to confirm to myself what readers have been saying for several years. The audio quality of many radio stations is seriously declining.

With modern car radios, it's easy to scan every available station. Armed with 15 or more station presets, a driver can quickly tune from one station to another. Because drivers are no longer encumbered by a linear tuning knob, selection of another station is as simple as pressing a button. This is a convenient feature for the listener, but can prove to be a problem for the radio station. The easy access to a number of stations makes it possible for your listeners to compare not only programming, but more importantly — signal quality between stations.

This summer, I was located in an area centered between two major markets. Each market had one station carrying the same satellite-delivered programming. Therefore, it was easy to compare the audio quality between the two stations. The difference was quite apparent.

The audible differences were not so much loudness as clarity and frequency response. On one station, the highs were brighter and compared favorably with CD reproduction. The other station's signal was louder and more compressed. However, the most obvious difference was the lack of high frequencies, even to the point of sounding dull.

Here were two stations carrying the identical programming, delivered from the same satellite. Yet, the quality of the transmitted signals was noticeably different.

For several weeks, I verified the quality difference of the stations. I then compared the lesser-quality station's signal to other competitors. The result was the same. The muddy-sounding station didn't compare favorably to some of the other stations either.

Don't get me wrong, even the lesser-quality station's sound wasn't bad, and it was certainly nothing the FCC would be concerned about. But, the signal quality was not as good as the station's competitors.

There could be a lot of reasons for the quality differences. Equipment, budgets or other factors could be argued as the cause. Maybe they were factors, but one fact struck me as particularly noticeable.

The lesser-quality signal came from a station with a *part-time* engineer. The higher-quality signals came from a station supported through the full-time staff of the companion TV facility.

Even the best managers or owners have their hands full trying to be financially successful. This may leave little time (or inclination) to really listen for technical problems. This task was formerly handled by the engineer.

Managers, if you don't have a full-time engineer or one working closely with you to ensure consistent high quality, you're courting disaster. It's only a matter of time. You can ignore the reality of signal deterioration for only so long. Sooner or later, the results will become obvious to your listeners — and advertisers.

In today's competitive marketplace, the success and future of your station may depend as much upon technical excellence as programming. When this happens, your engineer could turn out to be the best marketing tool you've got.

Brad Dick

Brad Dick,
editor

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Signal leakage forces cable system shutdown

By Harry C. Martin

In June, the FCC's Kansas City regional office issued a cease operations order to a Kansas cable system after an inspection revealed signal leakage in excess of the commission's standards. The investigation was part of an on-going initiative designed to promote safety in air navigation by reducing potential interference by cable TV systems.

Cable systems employ a closed, non-radiating circuit system that uses the same radio frequencies as other radio services, including the aeronautical service. Signal leaks (system radiation) that cause a system to exceed the "cumulative leakage index" (CLI) as set forth in section 76.611 of the commission's rules present potentially harmful interference to aeronautical communications in the 108-137MHz and 225-400MHz frequency bands.

The Kansas cable system immediately complied with the FCC's order by shutting down operations on channels in the aeronautical bands and took immediate action to reduce the leaks. The system was not permitted to resume full operation until it complied with the commission's CLI standards.

FCC studies efficacy of TV rules

The commission has begun an inquiry proceeding in which it is seeking public comment on changes in the state of the video marketplace and the public policy implications of such changes. Specifically, the inquiry will focus on these policy implications: 1) Technological advances in video delivery systems, such as digital signal compression techniques; 2) The increasing competition in, and fragmentation of, the video marketplace as a result of technological change; 3) The ability of some competitors to rely on revenue from direct viewer payment instead of, or in addition to, advertising; and 4) The rapid increase in the availability of national sources of programming.

The inquiry was prompted by a working paper prepared by the FCC's Office of Plans and Policy (OPP), which catalogued a number of trends in the video marketplace that may be eroding the policy basis for many existing FCC rules, particularly those that limit and restrict multiple and cross ownership of TV stations with other media.

Copies of OPP's working paper (No. 26), "Broadcast Television in a Multichannel Marketplace," are available through the commission's duplicating contractor, Downtown Copy Center, at 202-452-1422.

Digital voice encryption permitted for RPU facilities

As of July 25, the FCC is permitting the use of encrypted digital voice transmission by remote pickup broadcast stations. This change will help licensees prevent unauthorized interception and use by third parties of intrastation communications related to newsgathering and program production. The FCC's rule change takes into account the new frequency-modulated ("F1E") and phase-modulated ("G1E") ITU emission designators.

The new encryption methods will be confined to a nominal occupied bandwidth of 20kHz. This limit was retained because digital emission limitations are based on the use of a digitizing method, which uses the minimum signal sampling rate necessary for satisfactory voice intelligibility. The resultant emissions, the FCC said, are compatible with voice-modulated narrowband FM emissions traditionally used in the land mobile services and on most remote pickup channels. These emission limitations don't permit use of the wider bandwidths that would be required for digitizing systems using the higher signal sampling rates necessary for quality reproduction of high-fidelity programming.

Finally, the commission is requiring that stations using encryption transmit an unscrambled analog or international Morse code station identification at intervals not exceeding 15 minutes during operation, and that the parent broadcast station's call letters be used in all such identifications. The FCC said these requirements will permit easy tracing of a remote pickup source without resorting to the FCC's files.

Main studio and time-brokerage abuses cited

In a July decision, the commission fined a West Virginia FM station $10,000 for abdicating control of its facility, and for violating the "meaningful management and staff presence" requirement of the main studio rule. The station was rebroadcasting the signal of an independently owned AM station in its market pursuant to a time-brokerage agreement.

The FCC pointed to the following facts as evidence of an unauthorized transfer of control to the time broker:

- Although the time-brokerage agreement authorized the licensee to pre-empt or reject the broker's programming, that right had never been exercised.
- The licensee's actual role in the programming of the station (as opposed to what the contract said) was more that of a consultant or adviser than a decision maker.
- The licensee was indebted to the broker, who had financed construction of the brokered station, and there was no source of revenue independent of the broker's monthly payments. This suggested a lack of licensee control over station finances.
- The broker owned the brokered station's transmitter and negotiated for — and signed — the station's tower lease.

Because the broker had infused the brokered station with working capital, chosen and bought its equipment, selected its format and otherwise participated in and financed construction of the facility, the FCC found the licensee had abdicated de facto control to the broker. Also, as pointed out, the station was being operated at odds with its time-brokerage agreement, which provided for separate management and staff for the two stations.

With regard to the related main studio rule violation, the commission noted that the licensee's manager had not been regularly present at the studio facility during normal business hours. The station had one employee, i.e., the nominal manager, at the station's main studio, but on a part-time basis. This did not constitute a "meaningful management and staff presence" within the definition of the rule. Full-time managerial *and* staff presence is required, the FCC said.

Note: It is expected that the commission will relax its interpretation of the main studio rule so as to require only a management "presence," and relax the full-time physical presence requirement.

Martin is a partner with the legal firm of Reddy, Begley & Martin, Washington, DC.

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Jim Bernier, Director of Engineering
WTVH Syracuse

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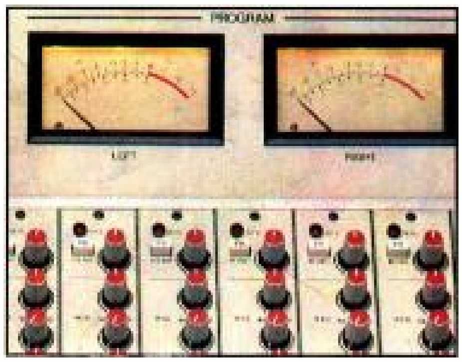

Detuned at last

By John Battison, P.E.

Earlier this year (in the March and April issues), I talked about plans for detuning a new FM/LPTV tower that was to be erected close to an existing 2-tower AM array. Weather and slow contractors played a part in delaying the detuning, so the end of the story was never told. Now, the detuning is finally completed.

During construction, various difficulties slowed the process. For example, while the FM antenna was being raised (I hasten to add that I was not present), the lower end of the center tube was left open and the inner conductor fell out, ending up in a bent mass on the ground 250 feet below. After obtaining a replacement, the antenna was safely raised several weeks later. The presence of a station chief engineer could have prevented this accident.

Final array tuning, adjustment and proof can delay the air date for a new station.

The trials of detuning

I tried twice in vain to detune the tower. The first time, lighting and coax lines had not been bonded to the tower. The second time, the detuning skirt had not been completed. Finally, one glorious day I arrived and found everything ready.

During the tower work, the AM transmitter had been operating on reduced power (with an STA) to keep the monitor points within limits. After the detuning skirt's installation (but before tuning), I put the transmitter on full power and went to read the monitor points. They were both out, but not as much as they were before the skirt was installed. This was an interesting development. I returned to the site, and with a quick in-line bridge check, verified that the common point impedance was still correct. Plate voltage and current were noted as well as I_{CP}.

With reduced power on the transmitter, I placed the field-intensity meter (FIM) on top of the detuning box, close to the down lead, and tuned in the carrier with the attenuator on highest range. The meter went to half scale, so I raised the power to its full 500W. The FIM reading went up slightly, and I started detuning.

Tuning was quite broad, and there was a choice of several turns for the tap to give the highest reading. Finally, I found one that I liked and left the tap in position. Then, I went back to the monitor points.

Number one was nicely in at 14.9mV/m (maximum is 18.1mV/m). Number two, usually a bit tricky, was also in at 5.1mV/m (maximum is 7.1mV/m).

A couple of quick spot measurements on other radials confirmed that the array seemed to be in. So, upon my return to the transmitter, common point impedance and current were checked, as were antenna monitor readings, plate current and voltage.

A few more monitor point checks were made as the phasor was adjusted. You might recall that the LPTV antenna was originally located on the south tower of the array. This had resulted in a +3° change to +106° for tower 2's phase to obtain the original pattern and keep the monitor points in.

Detuning box containing inductor (left) and capacitor, with base of new tower directly behind. Note detuning skirt wires around tower, terminating at feedthrough insulator on top of box.

Completing the checks

After these measurements had been completed, a final transmitter/phasor check was made to ensure the licensed values were set. The array was then handed over to the chief engineer to go and perform the hard work of running radials.

The radials showed a nice agreement with the original proof, although most were slightly low — a ratio of approximately 0.98:1 instead of 1:1. But this difference was negligible, and certainly much more acceptable than 1.1:1 or higher.

After detuning, the most favorable tower 2 array operating parameters appeared to be 1/ +102°. Therefore, FCC Form 302 now shows this for the new operation.

This partial proof was made for the purpose of requesting a return to direct measurement of power following the construction of a new FM tower. This put a time constraint on us. The FM Form 302 for license must be filed within 10 days of program test and airing commercially. Furthermore, the required *AM* Form 302 for return to direct measurement of power and new license application had to be filed simultaneously with or before filing the *FM* Form 302. Therefore, the chief engineer had to work fast to get the radials done and sent to me in time. That's the biggest problem in cases like this. Final array tuning, adjustment and proof can delay the air date for a new station. It is wise to allow twice as long as common sense would dictate to do the final tuning.

The FM Form 302 for license must be filed within 10 days of airing commercially.

Battison, *BE's* consultant on antennas and radiation, owns John H. Battison and Associates, a consulting engineering company in Loudonville, near Columbus, OH.

Extreme Measures

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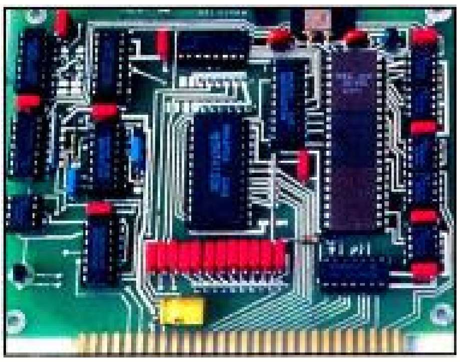
Part 1

Circuits



An in-depth look at analog ATR circuits

Bias circuits for ATRs

By Gerry Kaufhold II

This month, we kick off a fresh concept for the "Circuits" column. Reverting back to the earlier days of *Broadcast Engineering*, the "Circuits" column will dovetail with the "Troubleshooting" column on page 18 to show a detailed look at a particular component of an analog audiotape recorder.

This month, we will examine the biasing circuit that helps improve high-frequency response of the record section of an analog audiotape recorder.

The overall bias function has five parts:

1. the bias power switch;
2. the bias oscillator;
3. the bias harmonic filter;
4. the bias trap; and
5. the bias dummy coil.

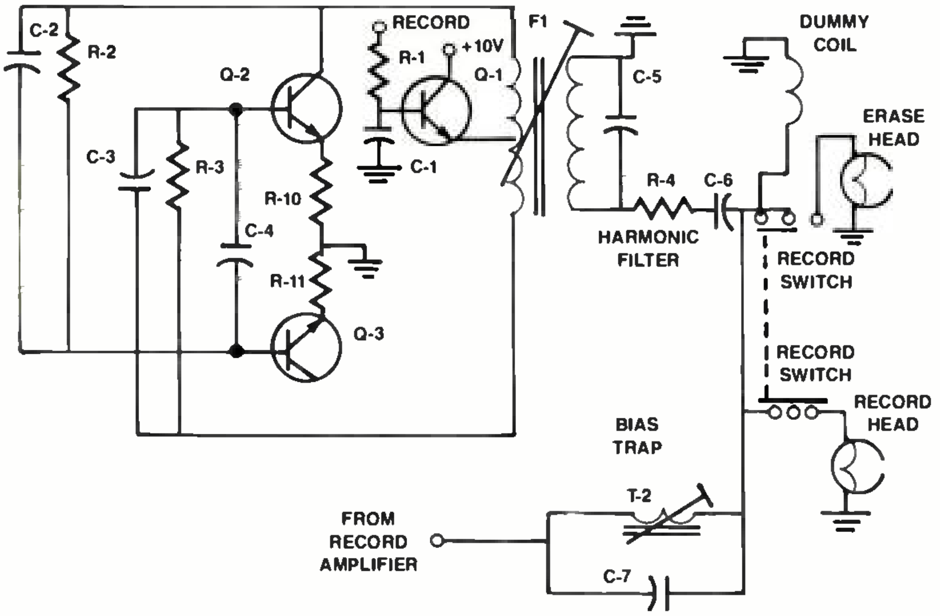


Figure 1. Diagram of a typical bias oscillator circuit.

Bias power switch and oscillator

Figure 1 shows a typical bias oscillator. This is a traditional flip-flop using discrete transistors.

Bias is only active when the recorder is in the record mode. Bias is switched on and off by controlling power into the bias oscillator.

When the record switch is active, it applies a positive voltage to transistor Q-1, which saturates to connect +10VDC to the center tap of transformer T-1.

The base networks of transistors Q-2 and Q-3 are identical, within the limits of component matching. There are +10V that feed through the windings of T-1, through 27kΩ resistors R-2 and R-3, and charge up capacitors C-2 and C-3.

In order to make sure that transistor Q-3 fires first, a "jump-start" polarized capacitor, C-4, is applied between the bases of Q-2 and Q-3. The positive side of C-4 acts as a low impedance to the incoming current from T-1, delaying the turn-on cycle of transistor Q-2.

The delay lets transistor Q-3 turn on first, saturating the collector-emitter junction to approximately 0.3V.

Transistor Q-3 acts as an effective short circuit. As soon as the center-tapped coil of transformer T-1 has discharged through Q-3, no current flows through the base-emitter junction of Q-3, turning it off.

As soon as Q-3 turns off, the base of transistor Q-2 begins to turn on — repeating the cycle and causing the circuit to oscillate with a clean sine wave whose frequency is dependent upon the values of R-2, R-3, C-2, C-3 and the inductance of transformer T-1.

T-1 can be adjusted to provide the exact bias frequency, which should be around 125kHz.

Harmonic filter

The oscillator is coupled through a tunable LC network made up of the parallel combination of T-1 and C-5.

Resistor R-4 and capacitor C-6 provide a series-tuned bandpass filter that rejects all but the fundamental bias frequency, which should be set to approximately 125kHz.

Bias trap

The bias trap acts to block the bias oscillator frequency from getting into the other record function amplifiers. The record amplifiers are tuned to provide optimal frequency response for incoming signals. These amplifiers would cause serious distortion if the bias frequency were to bleed into them and be amplified.

The bias trap is a parallel-tuned notch filter made up of tunable coil T-2 and capacitor C-7. When properly tuned, this network presents a high impedance to the bias frequency — effectively blocking it from the sensitive record mode amplifiers.

Dummy coil

The dummy coil provides a dummy load to the bias oscillator circuits during non-record modes. When record mode is enabled, the dummy coil is disengaged, and the full-strength bias signal is applied to the erase heads.

If there was no dummy coil to provide a load during non-record modes, the oscillator might detune, and sweep through an audible frequency range on the erase head, imparting an audible and annoying "popping" sound to the tape the instant that the record mode is entered.

Dummy coils were developed to permit audio engineers to transparently "punch in" and "punch out" during a recording session. This popular feature of modern-day audio recording depends upon proper alignment and tuning of the bias oscillator circuit.

Kaufhold is an electronics industry analyst based in Tempe, AZ.

Courtesy of A.F. Associates

Control room of ABC Sports mobile unit.

Audio-video control systems

Careful design from the ground up can be the solution to interfacing audio, video and digital signals.

Some of today's production and control rooms resemble the complexity of a NASA space center. And, as complex as today's systems are, even more complicated devices are on the technological horizon.

Technical managers face a bewildering array of challenges when it comes to production and control room design. Analog, digital, composite and component are only part of the video signal issue. Add analog and digital audio signals, mix in a little MIDI and serial LANs for control, and the complexity of building and operating a video or production environment seems unsurmountable.

Fortunately, although technology increases the complexity of our lives, it also simultaneously creates new solutions. Often, these solutions lie in new and more powerful hardware. The task of the technical manager then becomes the effective use of this new equipment to the best advantage of the facility.

In this month's special coverage, we will cover some of the new technology solutions now available to the TV and production facilities. The proper use of some of these ideas can reduce costs, improve the flexibility for operators and maybe even increase your facility's competitive advantage.

"Advantages of 3-Stage Switcher Design" provides a thorough review of routing switcher design. Using techniques developed almost 40 years ago by Charles Clos, the author shows how it's possible to reduce the number of crosspoints in a 100×100 switcher from 10,000 to only 5,700. The result is a savings in cost and complexity.

Reducing switcher size isn't the only important consideration when handling audio and video signals. The requirement to handle digital and component analog video signals simultaneously creates even more challenges in routing and control. The article, "Implementing Multiformat Routing Switchers," shows how a virtual matrix forms the basis for a well-designed switching system.

As new digital video formats become available and facilities examine ways to implement HDTV, controlling these signals increasingly becomes the topic of much concern. Switching and routing the high-speed signals can be a difficult problem. Instead of relying on coax, many view fiber as the routing solution. The issue then becomes switching. Is it possible to build a fiber-optic routing switcher? The answer is yes and the authors detail how in "Fiber-Optic Routing Switchers."

"The On-Line/Off-Line Interface" article sets the stage for compatibility between editing systems. Without advance planning, editors may find themselves working in expensive editing suites when most of the work could have been done in much less expensive off-line facilities. See how your editors can benefit with a little forethought.

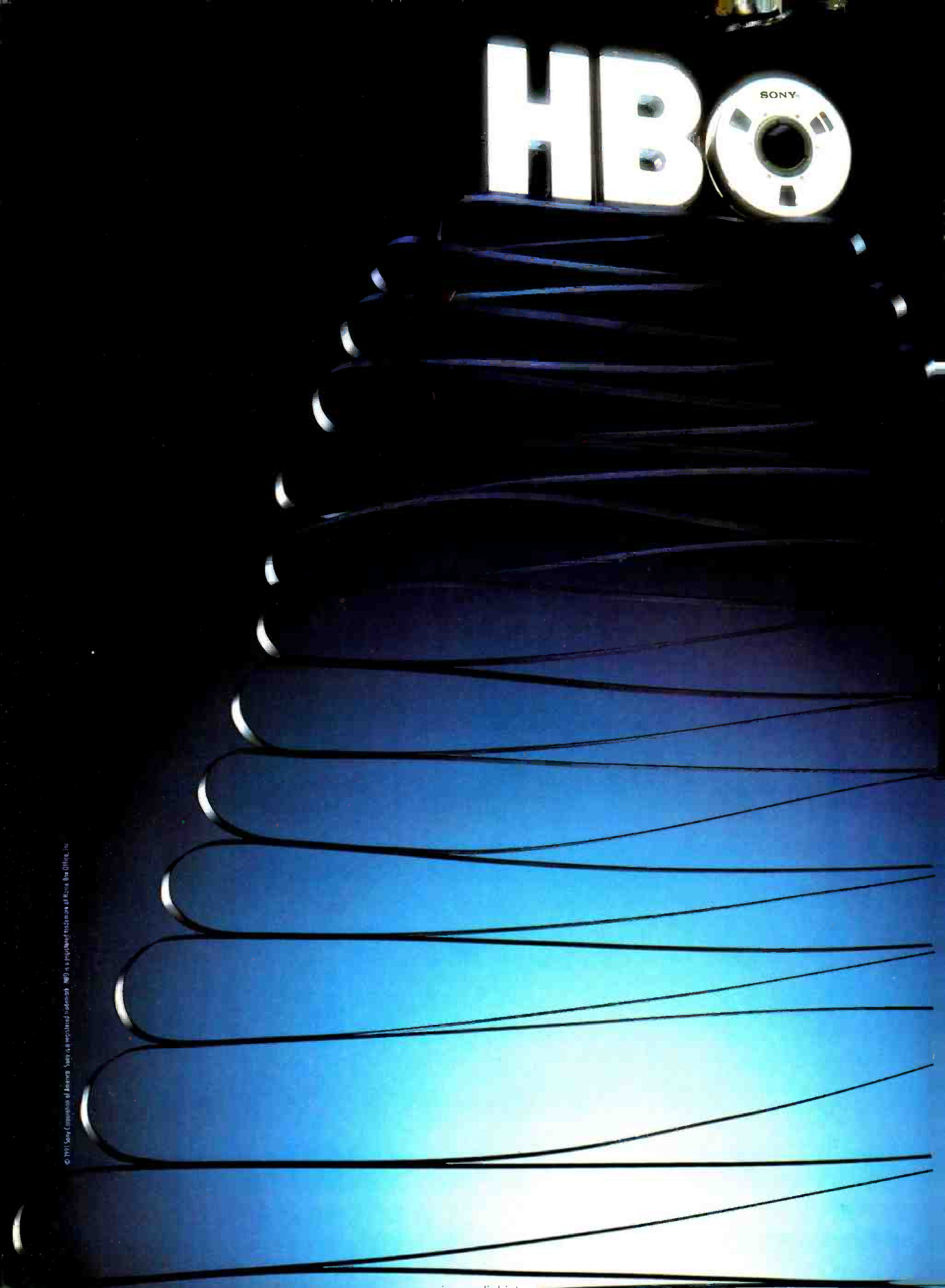
Need to store a lot of still video images? "Archiving for Productivity" shows you the technology behind an electronic video filing system. Based on magneto-optical storage, large graphic image storage becomes possible — with accessibility of these images to multiple users.

Now that you've planned the use of these new technologies, they have to be properly controlled. "Integrating Multiple Control Systems" provides an overview of some important considerations when planning that next video facility.

The ever increasing pace of technological developments challenges technical managers on many fronts. The systems designed today must serve not only today's needs, but also those of tomorrow, when the requirements may be quite different. Fortunately, solutions are available in modern production hardware.

Brad Dick

Brad Dick, editor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switching," because an input may feed many outputs (point-to-multipoint) rather than common switcher applications in telephone systems. At first, this appears simpler than point-to-point operation because many inputs will not be in use at a given time.

However, computer simulations show broadcast switching actually requires *more* middle matrices than point-to-point switching. In a simulation of a 100×100 switcher with random selection of inputs and outputs for switching commands, the number of middle matrices used increases to 19. This is still within the Clos count, but is more than the 17 used in the purely point-to-point case. For this test, many inputs will be used by one or two outputs, with a few used by three or more outputs, and many inputs not used at all. Although this is similar to what actually happens in a TV application, a more difficult pattern was developed to approximate typical usage in a TV facility with greater precision. Here, one input was used by four outputs, the next 10 inputs were used by three outputs, the next 10 inputs were used by two outputs, and the remaining inputs were used by one or no outputs. This means that 31 outputs were being fed from the first input matrix, and 21 outputs were being fed from the second input matrix. (This was intended to model the heavy usage of certain signals, such as black, color bars, network, program and so on.) A simulation was run where one million takes were made while maintaining the loading on the inputs. This simulation required 22 middle matrices to prevent the blocking.

Figure 3 demonstrates blocking in a system of reasonable size for presentation here. Although this small system doesn't save crosspoints, blockage occurs in the same way in a large system. Figure 3a is the starting condition for a demonstration of switcher blocking, with all outputs switched to their respective inputs. In Figure 3b, output 5 was switched to input 2, requiring use of the fifth middle matrix, because no path was available through the first four middle matrices. Figure 3c shows output 6 switched to input 3, and then output 7 switched to input 4. These selections required the use of the sixth and seventh middle matrices because other paths were not available at that time due to the order of the switching requests. Several selections are now blocked. For example, output 10 can't be switched to input 1. Note that output 5 can now reach input 2 by signal copying in the second middle matrix, and output 6 could reach input 3 in the third middle matrix.

The increase in middle matrices may be a significant problem if the switching matrices are constructed out of standard building blocks. In the previous example, an increase from 19 to 20 middle matrices only costs one additional middle matrix and the associated interconnection cables. But the increase to 21 or 22 middle matrices requires the input matrices to provide more outputs, and the output matrices to provide more inputs. Because the matrix blocks come in increments of 10

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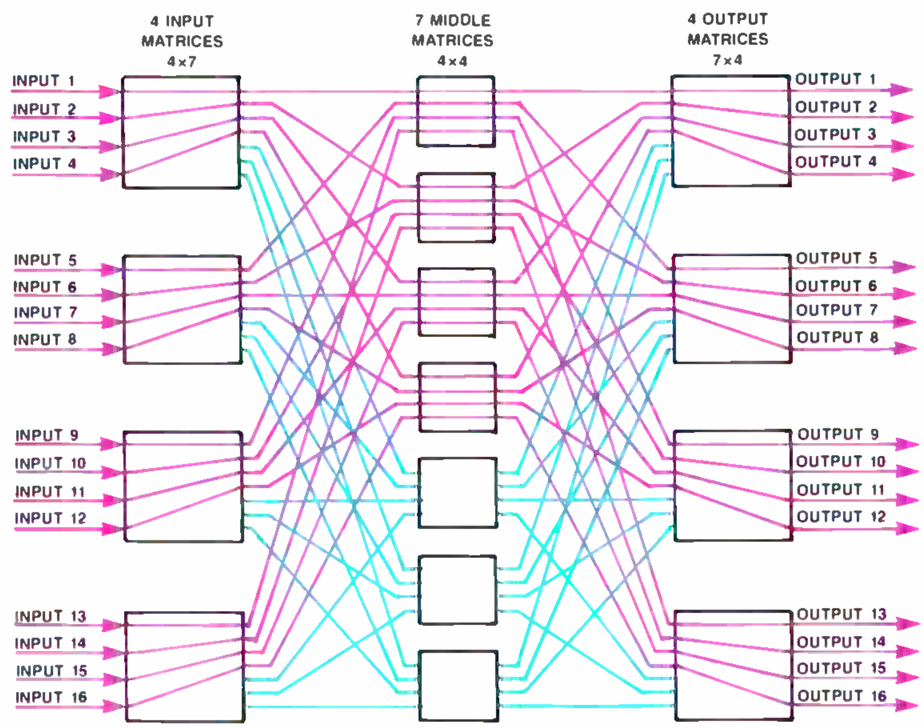

Figure 3a. *A 16×16 switcher with inputs switched to matching-numbered outputs, point-to-point. Only four middle matrices are required.*

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"Little Death" created by Matt Elson for Symbolics Computer-Symbolics. "Chinese Man" created by Lavoni Design for Abekas Video Systems. "CNN Newsource Extra" created by Michael J. Lizak at Digital Post and Graphics for Turner Broadcast Systems

Continued from page 32
inputs and 10 outputs, the crosspoint count increases from the original 5,900 to 8,200 for a system with 22 middle matrices. In a carefully contrived switching sequence — one that would not be likely to occur in normal operations — it is possible to use up to 40 middle matrices in a 100×100 switcher. That system would require 12,000 crosspoints to construct, or 2,000 *more* crosspoints than a single-stage switcher. The switching of inputs to multiple outputs creates an effect similar to increasing the number of inputs on an input matrix, therefore making broadcast switching more difficult than point-to-point switching. However, there are ways around the problem.

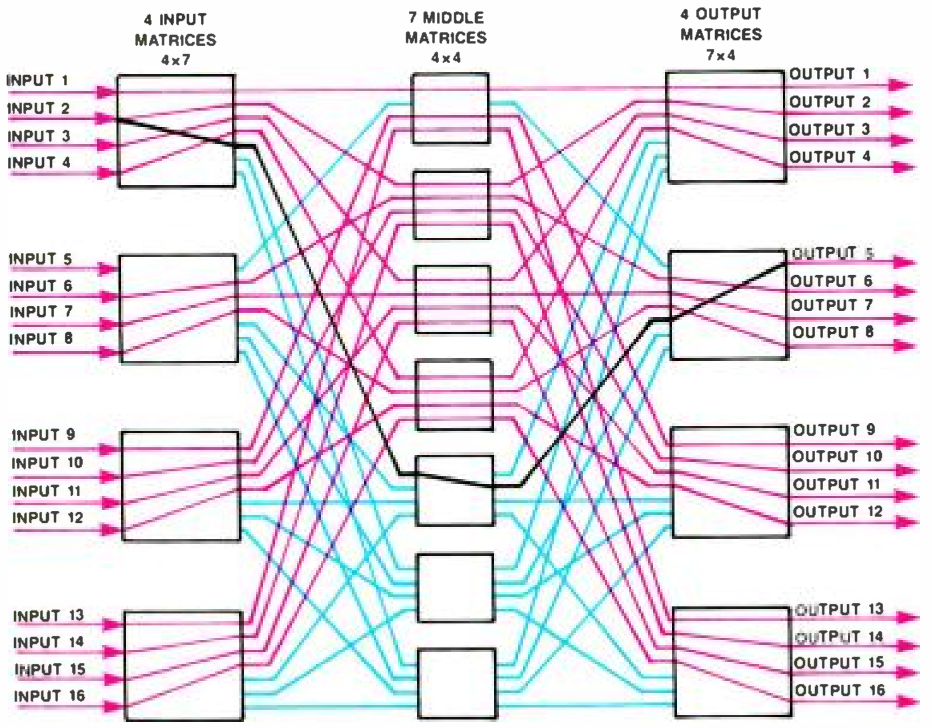

Figure 3b. *Changing output 5 to input 1 requires a fifth middle matrix.*

The blockages always occur at the output of an input matrix, (between input and middle matrices), typically under the following scenario. When a single input is directed to many outputs and the number of outputs required exceeds the number of outputs on a middle matrix, a second middle matrix must be used. However, a path from the original input matrix may not be available to feed that second middle matrix if other inputs in that input matrix are also being heavily used. But when only one or two inputs are heavily used, the blockages do not occur. For example, if the input loading of the previous case is distributed across all of the input matrices such that the first input matrix has an input used by four outputs, each input matrix has one input used by three outputs, one input used by two outputs, and the remaining inputs used by one or no outputs, the number of middle matrices needed is reduced from 22 to 17. This is a significant reduction for simply spreading the load evenly among all input matrices. Sharing the input loading will prevent blocking and allow the benefits of multistage switching to be used in broadcast switching applications.

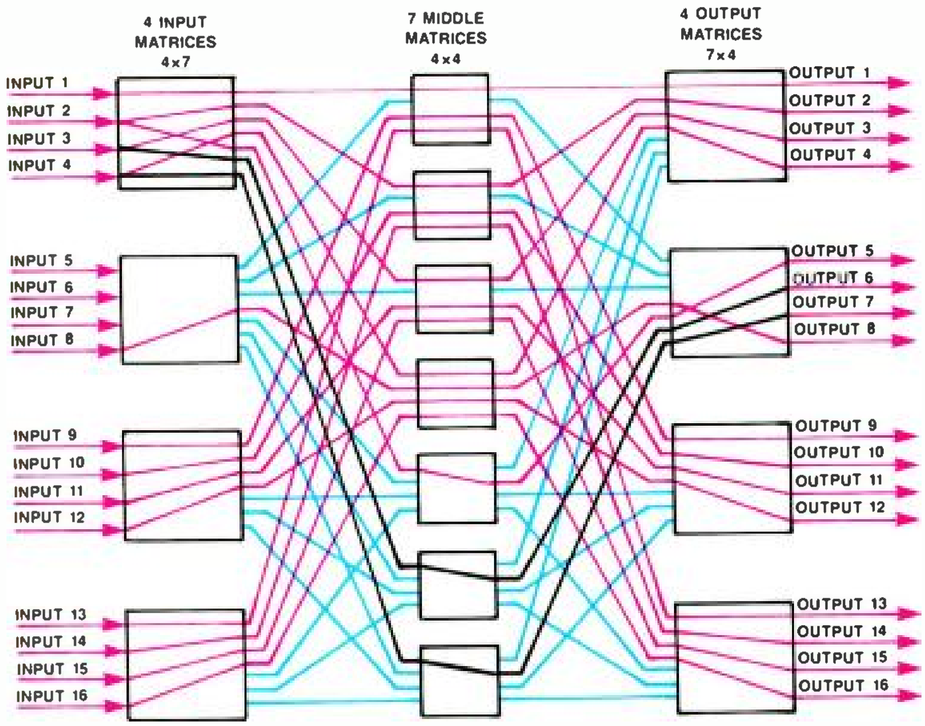

Figure 3c. *Next, output 6 is changed to input 3, then output 7 to input 4. This takes all remaining middle matrices. Now, when output 10 tries switching to input 1, it is blocked. No open paths are available between middle matrices and the first input matrix.*

Rearrangeable switching

Because the needs of a TV facility change daily, perhaps even hourly, an additional safety net is advisable. This is because a given input matrix may get heavily used at some time, allowing a blockage to occur. Referring to telephony research, it has been proven that a *rearrangeably non-blocking* point-to-point switcher can be constructed with only *m* middle matrices. This means only 10 middle matrices are needed for the 100 by 100 example switcher in point-to-point operation. Rearrangeably non-blocking means that if a path from an input matrix to an output matrix is not available, one can be opened by moving some of the other signals to different paths without interruption. Such "smart" systems can re-route complete paths via different middle matrices, or accomplish multiple outputs from single inputs by using *signal copying* in the middle and output matrices. (The latter process makes these matrices capable of point-to-multipoint switching.)

Figure 4 illustrates the results of rearranging. Figure 4a shows the same signal selections as Figure 3c, but all of the paths fit within the first four middle matrices. Signal copying in the middle matrices is used to feed outputs 5, 6 and 7, with out-

put 8 being fed through the first middle matrix. In Figure 4b, the previously blocked take of output 10 to input 1 is possible through the fifth middle matrix. Figure 4c shows how output 9 can be rerouted to permit output 10 to use signal copying in the first middle matrix.

Rearranging can be done without any loss or disconnection of existing signals by setting up each new path and switching to it *before* removing the old path. The only switch noticeable at the output will be when the output matrix changes from the old to new path for the same signal.

A 200x200 wideband digital routing switcher being installed at Madison Square Garden in New York. Beyond the operational advantages of such a routing system, its physical space requirements are typically less than an equivalent patchbay/DA system would require. (Photo courtesy of BTS.)

Therefore, any switching glitches or transients caused by rearranging will occur only once per output, not three times. If the switcher provides clean switching with well-matched paths, there will be no noticeable disturbance. This technique can work quite well when switching digital signals, as long as bits are not lost beyond recovery by a switching glitch.

It has been shown that a point-to-point switcher that is rearrangeably nonblocking can be constructed with n or more middle matrices. Up to n−1 outputs, 9 for this example, may require rearranging to open the necessary path in this switcher.[3] Because broadcast operation is more difficult than point-to-point operation, you should expect to use more middle matrices. The number of middle matrices required will depend somewhat upon the amount of rearranging that will be permitted. For a reasonable amount of rearranging, I recommend 20 middle ma-

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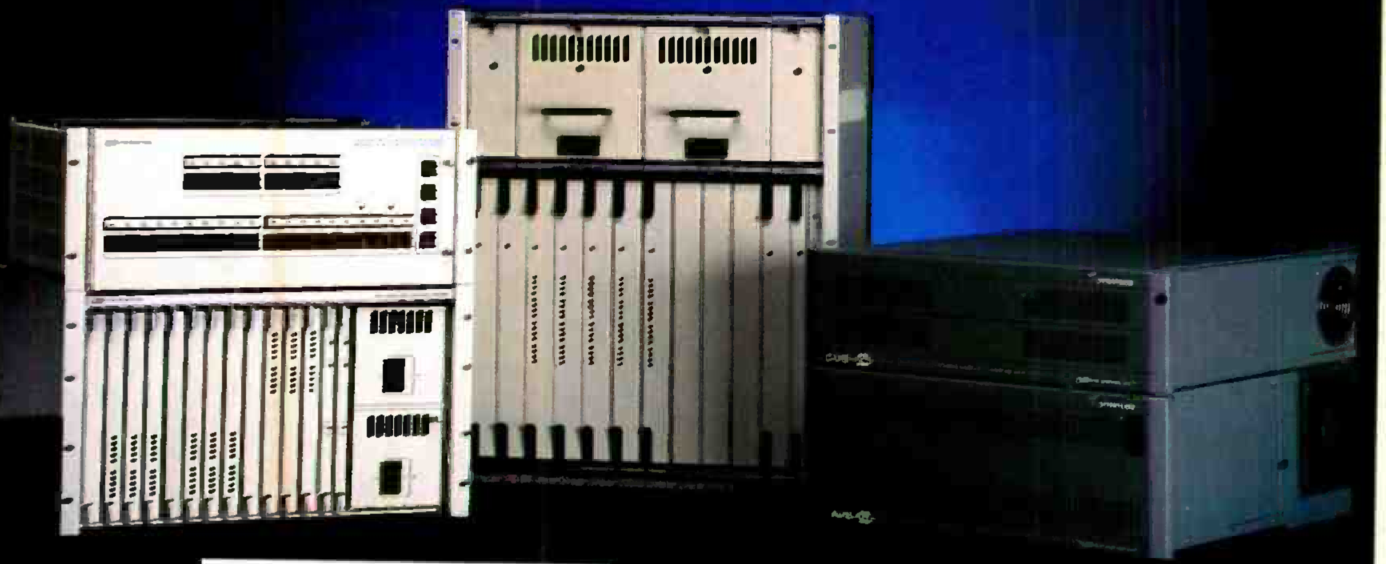

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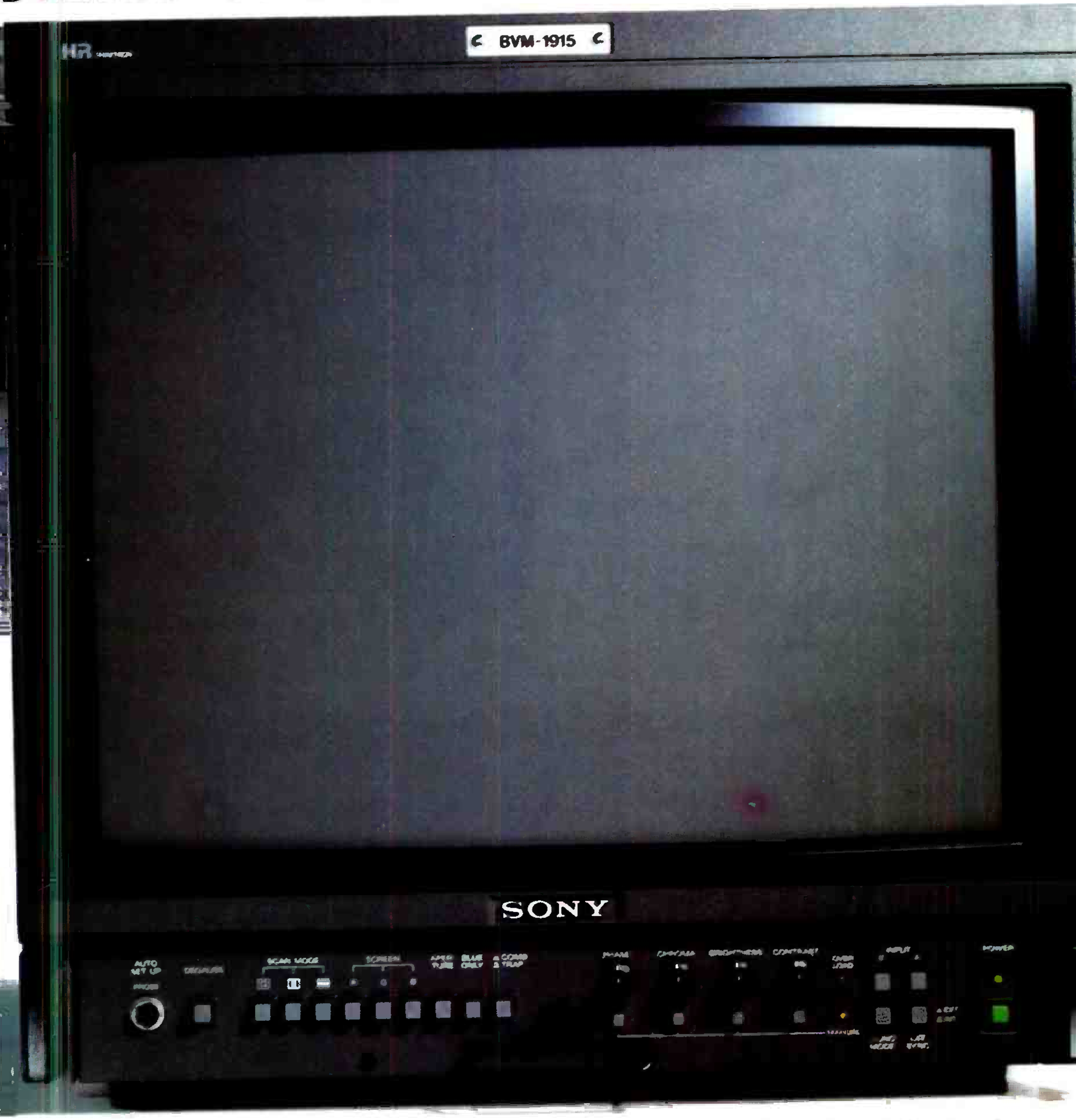

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Implementing multiformat routing switchers

A "virtual matrix" is the key to switching in a multiformat world.

By Dan Mazur

Improvements in TV technology are significantly changing the routing and distribution requirements of broadcast and teleproduction facilities. New switching systems must handle component analog formats, RS-232/RS-422, digital video and multiple analog and/or digital audio channels. However, integrating these smaller matrices with the main house routing switcher often requires a major rewiring of the entire facility, because of the limitations in the control logic of standard routing switchers. A *virtual matrix* control system can relieve this problem by mapping the relationship between all switching levels in software.

The need for routing switchers

The routine day-to-day recording, monitoring and maintenance needs of every teleproduction facility presuppose the ability to select from any number of available signals. At least some of these switching and distribution needs can be met with a combination of patchbays and distribution amplifiers. However, complex and extensive switching networks can be established and changed more readily with a routing switcher.

A routing switcher is capable of distributing a source signal to any desired destination within the matrix. This provides the best possible use of available hardware. Once a routing switcher becomes the central interconnect point for all equipment, uniform timing relationships and signal levels can be established throughout a facility. Equipment changes and facility expansions become greatly simplified.

There are operational as well as systems engineering advantages in using routing switchers. Control panels are usually installed in many areas throughout a facility, enhancing overall flexibility. Increasingly, these panels can be programmed to meet unique requirements. Software-based features now include the ability to assign inputs or outputs to specific buttons, the use of alphanumeric names instead of numbers to improve user-friendliness, and "protection" options to prevent unwanted switches from occurring.

Setups that are commonly used can often be defined on system terminals and executed as "salvo" switches. Many systems include a combination of local control panels, external computer control for automated time event switching sequences, and dial-up telephone control via DTMF codes. The control and distribution possibilities of a routing switcher matrix have become an indispensable design consideration in all but the smallest facilities.

Configuring a matrix

Routing switcher systems are typically manufactured as distinct video and audio matrices, capable of being controlled together. To achieve an audio-follow-video (AFV) switch, it is necessary to wire the video and audio signals to corresponding input/output locations on the router frames. In certain situations, it may be necessary to switch the video signal without changing the audio or vice versa. These special case AFV situations require control panels with the ability to independently "split" or "breakaway" the video and audio source feeds.

Routing needs must be reassessed in light of the technological advances that have improved video and audio signal quality. The most radical proposal for improved picture quality entails the complete replacement of all established video standards with a new high-resolution alternative. The 30MHz bandwidth necessary to realize HDTV specifications greatly exceeds the performance parameters that dictated most NTSC/PAL/SECAM router designs. Although wideband routing switchers are available, you should question whether all video crosspoints should be upgraded to meet this requirement.

Other improvements have focused on preserving the quality of existing signals through new recording technologies. Today's component analog video formats used for ENG (Betacam and MII) do not impose new bandwidth demands (unlike some other RGB systems), but they do require the simultaneous switching of three video signals. Many routers can only accommodate these requirements by slaving two additional video frames together. Few manufacturers offer a practical way of using remaining frame capacity for systems in the field. Fewer still can recon-

Mazur is a consultant to Di-Tech, Deer Park, NY.

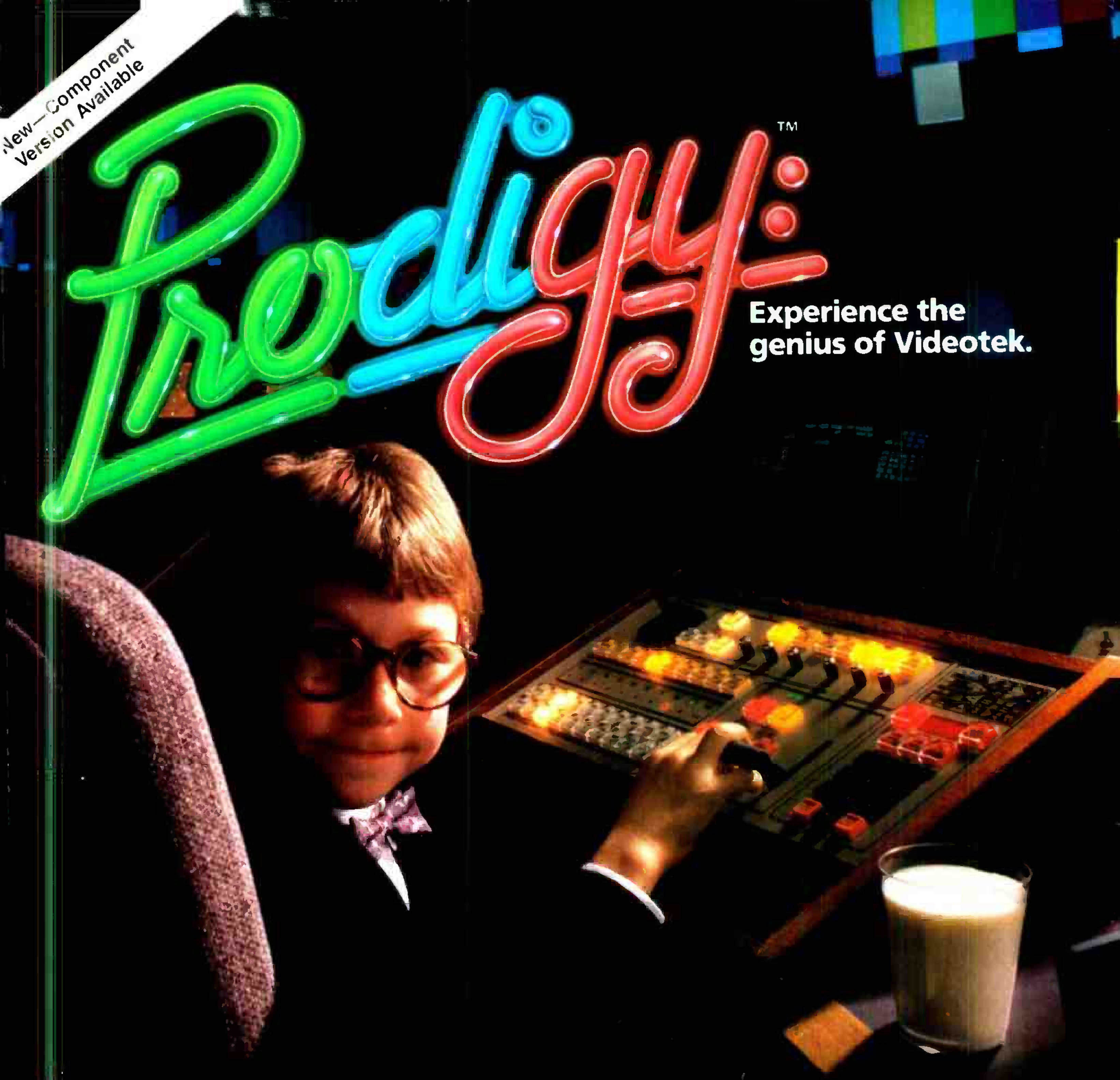
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figure a single chassis to route the four channels of audio that these tape formats provide.

Many of the newer VTRs provide the convenience of a separate, dedicated monitor output capable of displaying machine ID, diagnostic data and time code. For this reason, it is no longer safe to assume that a single video path is adequate to meet the switching requirements of *composite* video. Moreover, some recent production techniques require switching of video key as well as program video signals.

The D-1 and D-2 digital video formats require an entirely new breed of routing switcher. At present, this means a multipin parallel data transmission path, although serial digital switching systems are believed to be under development. The D-2 format has been promoted as a candidate for direct replacement of the type C VTR, by retaining significant levels of compatibility with existing routing switcher systems. For this reason, D-2 switching requirements can be anticipated in the analog and digital video domains.

Machine control functions provide another area that can be managed through a switching matrix. Now that RS-232/RS-422 serial control ports have become standard features of tape machines and related support equipment, it is practical to establish a central machine room with the entire house inventory available to edit suites as required.

Advances in control systems

Conventional switching logic defines crosspoints based upon their physical location on a switcher frame. A sensible alternative would entail using the advanced abilities of a microprocessor to define routing switcher control logic. Ideally, switching crosspoints should be selected on the basis of their logical and operational relationship to a given device, rather than how each switching level is connected on a frame. In short, it should be possible to completely "wire" the routing switcher via software.

This can be accomplished by creating tables of source and destination names, and then mapping the crosspoints associated with each name. Because a given name could refer to a single level or AFV device, the control system must consult these tables before executing any switch. (See Figure 1.) The term *virtual matrix* has been used to describe this type of routing switcher system.

A virtual matrix may be defined as a universe of input or output devices containing crosspoints on any physical connect point across one or more control levels. A system satisfying the following criteria would meet the design objectives of a virtual matrix:

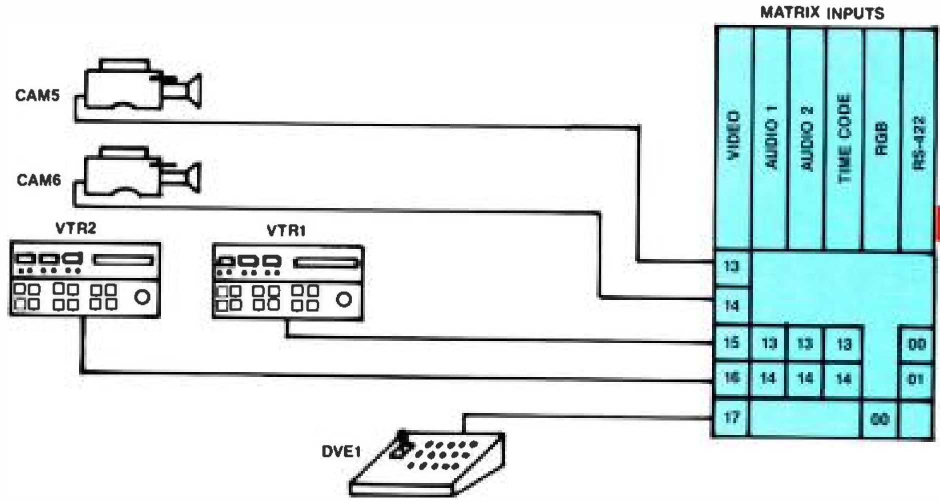


Figure 1. In a virtual matrix, all source or destination devices are named and assigned to specific physical input or output connections. An operator switching VTR1, for example, automatically selects AFV crosspoints on five switching levels. On the other hand, CAM1 is defined as a video-only switch.

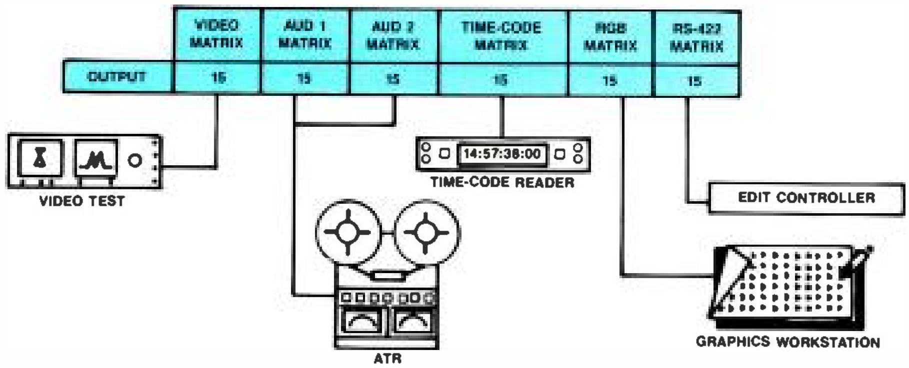


Figure 2. The virtual matrix allows each switching level of every output to be controlled independently. As shown here, physical output 15 has five separate destinations. A single switch combining outputs VIDEO-16, AUD1-20, AUD2-20, RS-422-15, for example, is also possible.

1. The system shall be based upon parameters that users set on-line via a system terminal. These parameters should include matrix size, number of control levels, source and destination names and virtual matrix switching tables.

2. The system shall be capable of single-level switches, multilevel switches (such as AFV), breakaway switches and "off" switches in order to prevent unintentional breakaways.

3. The switching matrix shall be defined in terms of source and destination names. Crosspoints associated with source or destination names may occupy any physical input/output connect point for each available control level. (See Figure 2.)

4. It should be possible to include a physical crosspoint in the definition of more than one device, to conserve router capacity and simplify operations. Confirming switch tallies should indicate this predefined "breakaway condition."

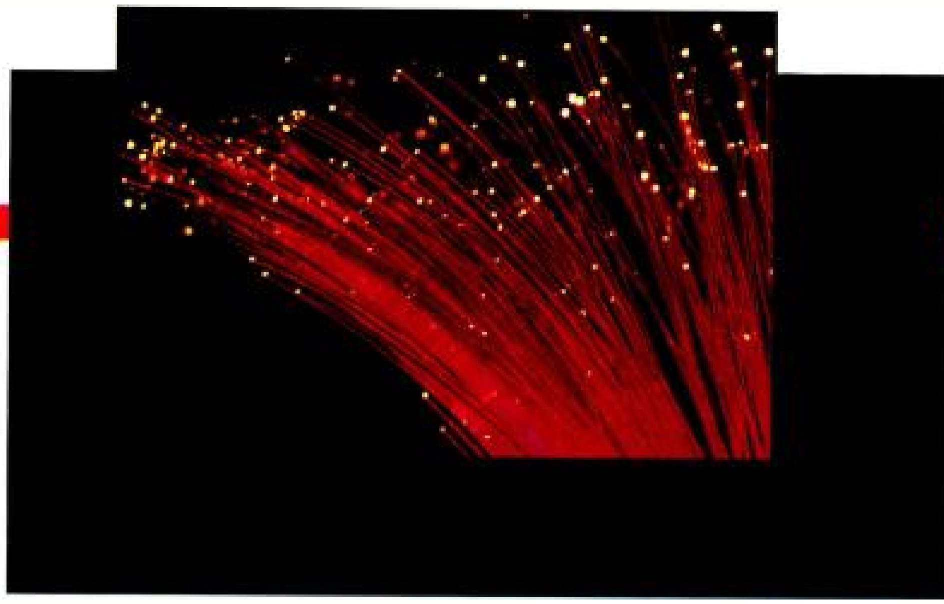
Certain operational features are essential to implementing and maintaining a virtual matrix, such as password protection, backup to floppy disk and provision for hard-copy printout. Power-line protection and backup electronics should also be provided to ensure reliability, and the system should be capable of detecting and rejecting improperly formatted or nonsense switch messages.

Benefits of a virtual matrix

Since 1987, routing switchers implementing virtual matrix control architecture have been in use at post-production houses, networks, news bureaus, TV stations and corporate video facilities.

Teleproduction facilities will probably continue to depend upon many small, special-purpose routing switchers. Virtual matrix control offers a proven method of re-integrating these switchers into a new master grid.

The implementation of such a "soft" and user-configurable routing mechanism, combined with wideband design, ensures flexibility and versatility for the foreseeable future of routing needs in the TV facility.



sions at the inputs and the outputs. The electrical signals are then sent to and received from the crosspoint modules via high-speed, controlled-impedance, board-to-board interconnects. All signal traces on the circuit boards are also of controlled-impedance microstrip.

The I/O modules always send and receive the same voltage levels to and from the crosspoint cards, allowing many different fiber-optic formats to be mixed in a system. The I/O modules are the "elastic" that allows for maximum flexibility in customizing every system for each application. For example, a system could contain single-mode and multimode fiber with low-cost LEDs and high-speed, high-power laser diodes, all in the same switching system. Also, various FO connector types, such as ST, SMA and FC, can be mixed. Coax I/O can also be easily accomplished with a modular approach, and can be mixed with fiber-optic I/O.

Because these are active systems, the data rates and wavelengths of the optical signals must be known in order to optimize the optical-to-electrical conversions. Another important piece of required information is whether the datastream contains *run-length limited code* (RLL). An NRZ datastream may contain a long string of continuous 1s or 0s. This is essentially a steady-state condition. Many high-speed data products contain AC- (capacitively) coupled circuits. AC coupling improves noise margin and simplifies some interface designs, allowing higher speeds and lower costs. But during long strings of continuous 1s or 0s, the coupling capacitor begins to discharge, leading to possible data error. One common solution is the use of run-length limited code. This encoding technique ensures that there will never be long strings of continuous 1s or 0s. Another solution is the use of DC-coupled circuits. Even there, however, long strings of continuous 1s and 0s can induce data errors if the clock and data recovery circuit at the receiver loses synchronization.

Two ways to switch fiber-optic signals are optically or electronically.

GaAs technology achieves high data rates

As the data rates through routers increase into the hundreds of megabits-per-second range, the switching capabilities of silicon-based crosspoint switches arrive at a physical limitation — the switches are simply not fast enough. They also begin to dissipate a great deal of power at these speeds. It becomes necessary to step up to GaAs-based ICs. Crosspoint switches using GaAs technology can be used up into the gigabits-per-second range with good signal fidelity.

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In addition to its speed-power advantage, GaAs exhibits a higher energy bandgap than silicon, yielding a potential for higher temperature operation, and, therefore, much better reliability. This translates into routers that have low failure rates.

Digital crosspoint attributes

The basic building block of the system described in this article is a 16×16 digital crosspoint switch cabable of operating at 2.6Gb/s. Typical video applications operate at only 270Mb/s.

The switch incorporates a non-blocking design, preventing routing problems from heavily used inputs and outputs. It can also be reconfigured at one time.

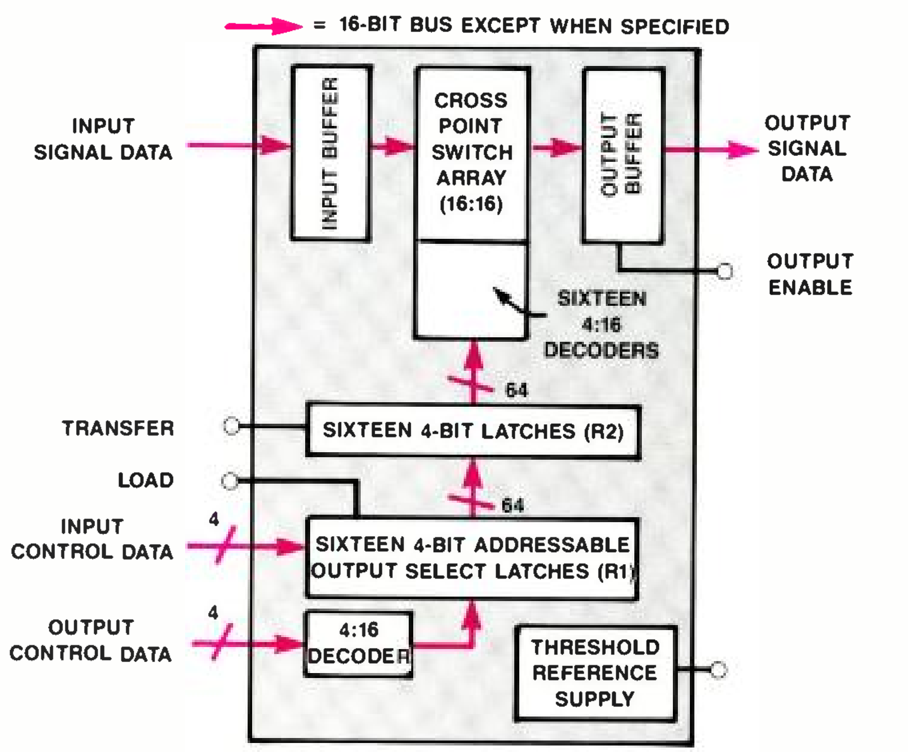

Figure 1. *This 16×16 digital crosspoint switch features a double row of input/output select latches (center). While the switch is active (transmitting) prior to a reconfiguration, the first row of input/output select latches (R1) is serially loaded at a rate of 3ns per I/O selection. When all I/Os to be changed have been loaded in R1, the content of R1 is parallel-transferred to the second row of select latches (R2), resulting in a complete switch reconfiguration in just 3.6ns. No data dropout occurs for any output whose input connection does not change.*

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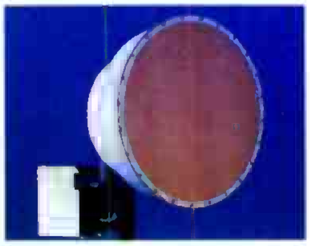

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ended crosspoint switch and a differential crosspoint switch at high data rates.

The next generation of crosspoint switches will be able to integrate 32×32 and 64×64 differential switch matrices at the same high data rate as is now possible in 16×16 modules. This will help reduce the board size and simplify the router design, because four 16×16 crosspoint switches are required to design a 32×32 switch matrix.

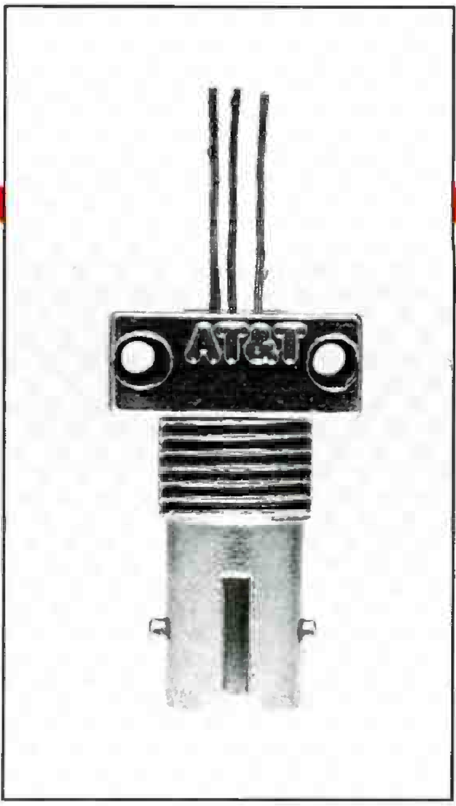
Finally, low-power GaAs or BiCMOS technologies and shorter gate length processes will be used to reduce power dissipation and simplify heat-sinking requirements.

As video production facilities have grown over the years, the routing requirements have become increasingly more complex. With many different types of signals, and the variety of production switchers, machine control and the many standalone "boxes" now available, the only element that they all may have in common is a facilities control system. Intelligent control has become a must; it's no longer a "wire-per-crosspoint" world.

Cost considerations

The cost of installing fiber optics is a good news/bad news situation. The bad news: The short-term installation costs will be slightly on the high side. The good news: The facility will have a much longer, more flexible and more productive life span, resulting in significantly lower long-term costs. There are also many ways to keep the short-term cost difference to a minimum. The bulk of this expense is in the connectorization of the fiber-optic cables, and the optical-to-electrical converters, the latter being where most opportunities to trim costs exist. Currently, the fastest, most powerful and most expensive drivers are laser diodes. Unless data rates are high, however, (300Mbit/s to 500Mbit/s or more) or signals must be transmitted over long distances (2km), these drivers are unnecessary. Most applications can use 820nm LED drivers on multimode fiber. The longer wavelength of 1,300nm LEDs makes them more expensive, but they exhibit less modal dispersion in the fiber, allowing greater transmission distances. They are also a little faster than 820nm LEDs. However, new research shows that the performance of 820nm LEDs may be greatly improved, providing high speed at low cost.

The price of the fiber-optic cable is al-



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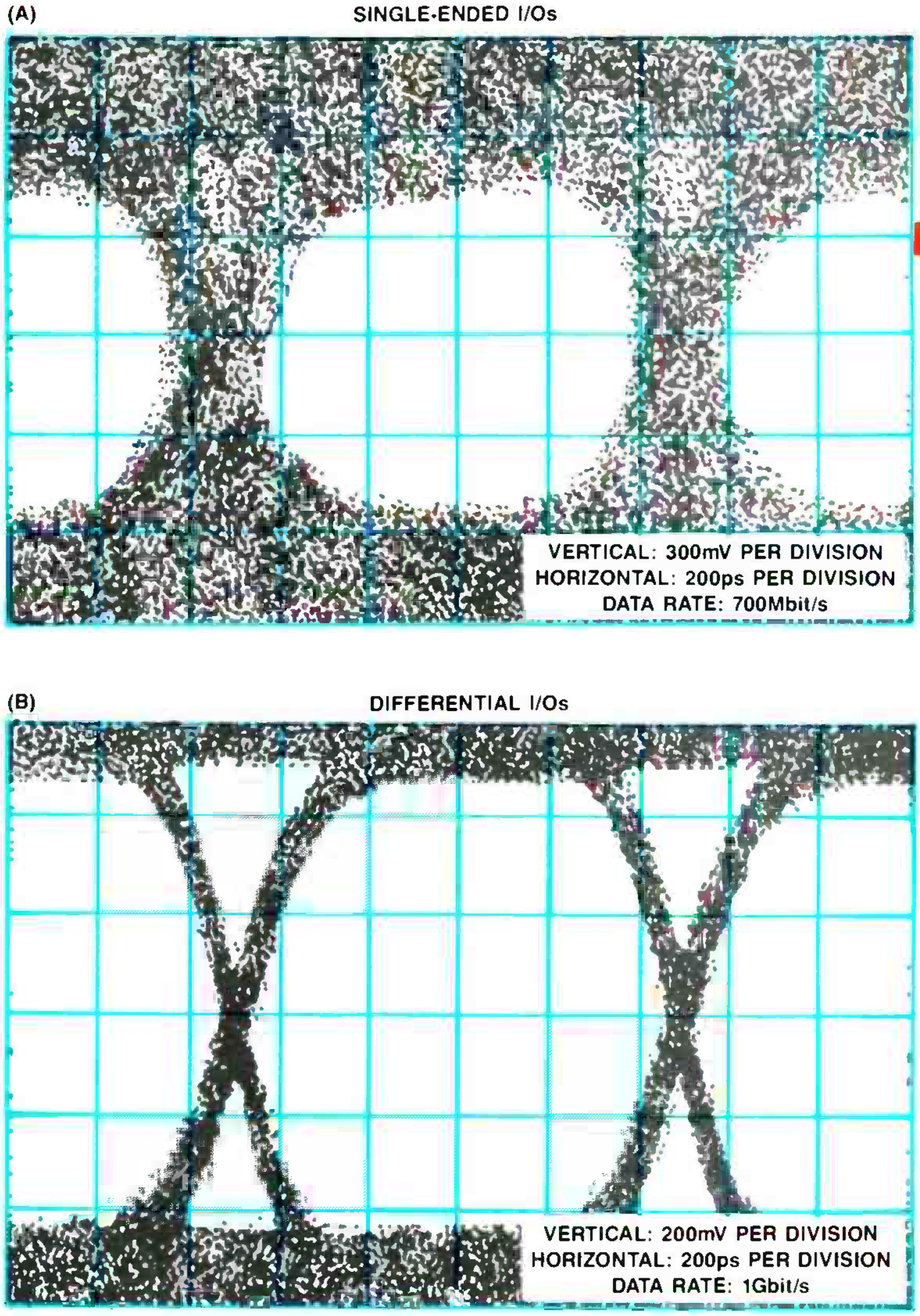

Figure 2. *In (a), "eye pattern" is shown for a digital crosspoint switcher using single-ended I/Os. Significant improvement is shown in (b), from reduced crosstalk when differential I/Os are used. Note that pattern improves even with somewhat higher data rate used in (b). (Courtesy of Integrated Switching Systems.)*

ready competitive with coax, and the video coax-to-fiber conversion process is easy and cost-effective. The original FO connectors of 10 to 20 years ago were expensive, unreliable and difficult to use. This is no longer the case. Today's FO connectors are strong, reliable, easy to use, efficient and cost-effective.

A great deal of ongoing research will likely produce continued improvements in optoelectric conversion and connectorization. This is a dynamic technology, but the basic optical fiber will remain fully compatible with all future updates.

One other major element in the cost of a system is its size. Today's basic building blocks run 16×16, with simple expansion to 32×32 or 64×64. Above 64×64, a number of new multistage non-blocking architectures should be seriously considered. These multistage architectures reduce crosspoint count, power consumption, size and cost. (See "Advantages of 3-Stage Switchers," pg. 26.) Full matrix configurations of 128×128 and much larger are currently possible, however.

Looking ahead, it seems clear that a new generation of cost-effective and easy-to-use fiber-optic components are synergistically merging with high-speed electronic devices. Together they can provide the capacities that the industry requires, at a price the industry can afford, in hardware that will remain viable and in service well into the future.

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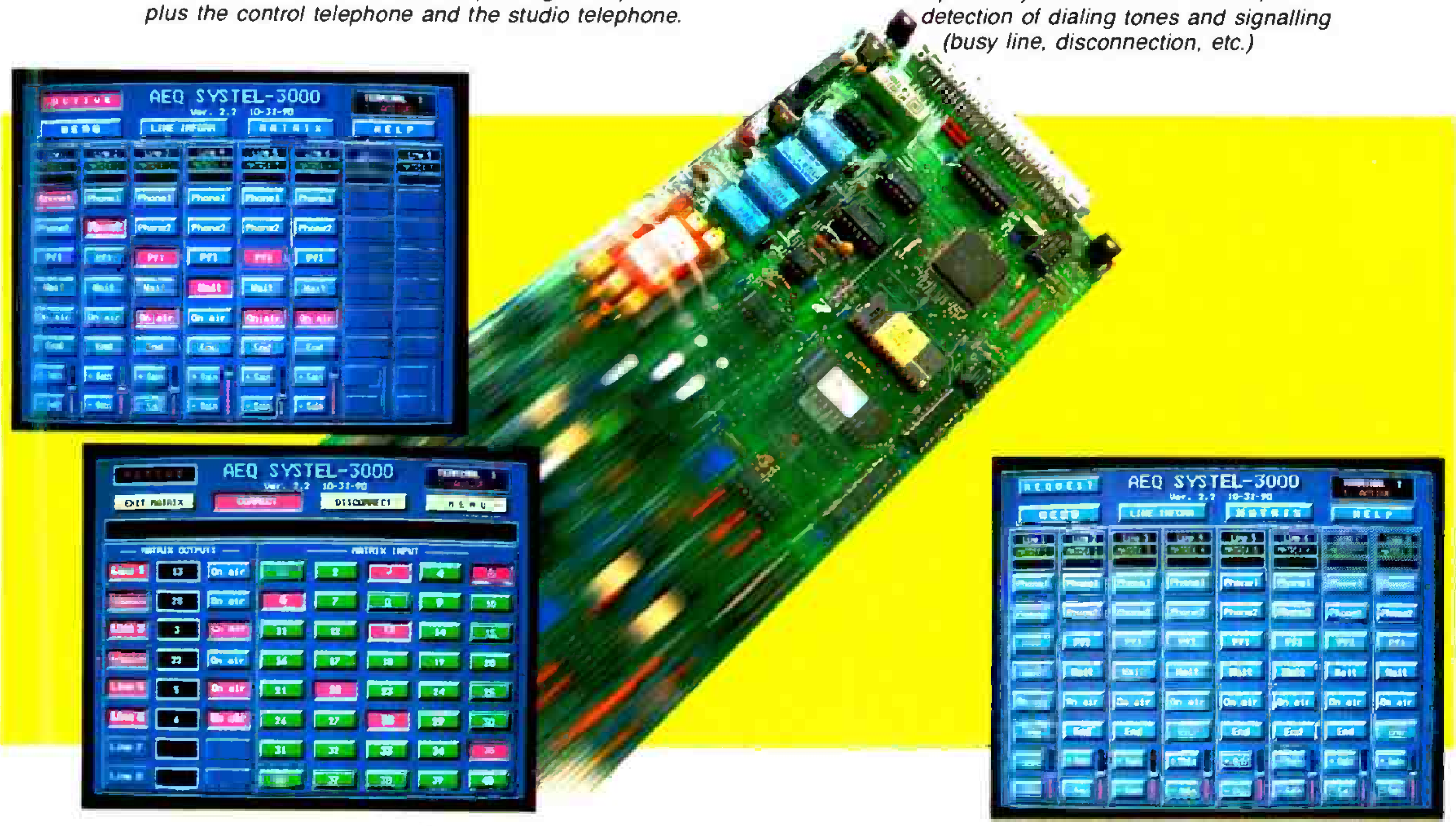

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Integrating multiple control systems

Computers simplify system control in modern broadcast facilities.

By Roald Steen

The history of automated control in the broadcast industry is almost as old as the industry itself. As soon as the first radio stations acquired equipment, engineers began to develop remote controls to allow operators to run equipment efficiently from a single location. It was the same with television. Master contrul and day-of-air switching centers needed centralized control to give the broadcasts a professional appearance, and to use manpower effectively.

Today, broadcast automation and control continues to be driven by these needs. This article will overview several new developments in the field of control.

Computers and microprocessors

Early automation systems consisted of custom-built chassis filled with relays and switches. These systems were often unreliable and frequently unserviceable.

Over the years, the systems typically acquired many additions and modifications, sume of which were undocumented. Eventually, new engineers and operators may have required extensive training before they could manage the many controls sprouting from the console. Much of the difficulty may have stemmed from trying to interface systems that were not compatible.

Steen is a certified electronics instructor and free-lance author based in Woodbury, MN.

The computer has formed a common interface between operators and many different pieces of broadcast equipment. (Photo courtesy of Odetics.)

The computer has recently made possible more powerful, yet simpler, control systems. With the computer, programs and commercials can be planned and scheduled long before they go on the air.

Lights, camera, action...

Computers can also now interface with many types of broadcast equipment, including the transmitter, tape decks, cartridge machines, studio cameras and


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lights. Automatic control requires that this equipment interface with the existing station control systems.

Desktop computers control many satellite uplinks and downlinks that are found in TV stations. Satellite control systems can energize the uplink, change transponders, and drive the actuators for antenna azimuth, elevation and polarization. Some systems can also perform unattended recording of incoming feeds and network delay tasks.

Automated switching of video, audio and data links are important functions. Manufacturers of routing switchers and other switching devices are now designing many products that can interface with desktop computers. This brings two advantages. First, it eliminates the cost of installing fixed control panels. Second, the computer front-end may require less operator training than a conventional panel. This is because the interface can effectively disguise the router from the user.

However, routing switcher manufacturers have increased their products' user-friendliness. Modern panels use mnemonics (source names) extensively, not input or output numbers. This makes operating the panel more intuitive. Also, the new breed of control panels is highly connective. Users can even communicate with some panels from remote locations via touch-tone or cellular phone. In fact, the new switchers are so adaptable that one company has installed large interconnect routing switchers in Los Angeles and New York. Subscribers can switch the inputs to their own facilities using little more than a router control panel. By taking the telco's old manual patchbay out of the loop, the subscribers avoid expensive switching fees, and get the feeds they need on demand.

Control locations

Although most facilities have a central control room, control of broadcasts is also possible from other locations. Control may be performed in the studio, in the newsroom, at remote sites, at the satellite downlink and at the transmitter site.

In effect, you could talk about a hierarchy of control points. Some modern broadcast centers' systems are designed along these lines. Local control is available when it is needed. When it is not required, control defaults to a central point. In this way, control rooms and other facilities need to be manned only when doing so may bring a bottom-line advantage.

In this discussion it would be helpful to broaden the definition of "control." In addition to denoting the power to make something happen by pushing a button, control can also be exerted by information — making a decision or voicing a command. In a live TV news program, for

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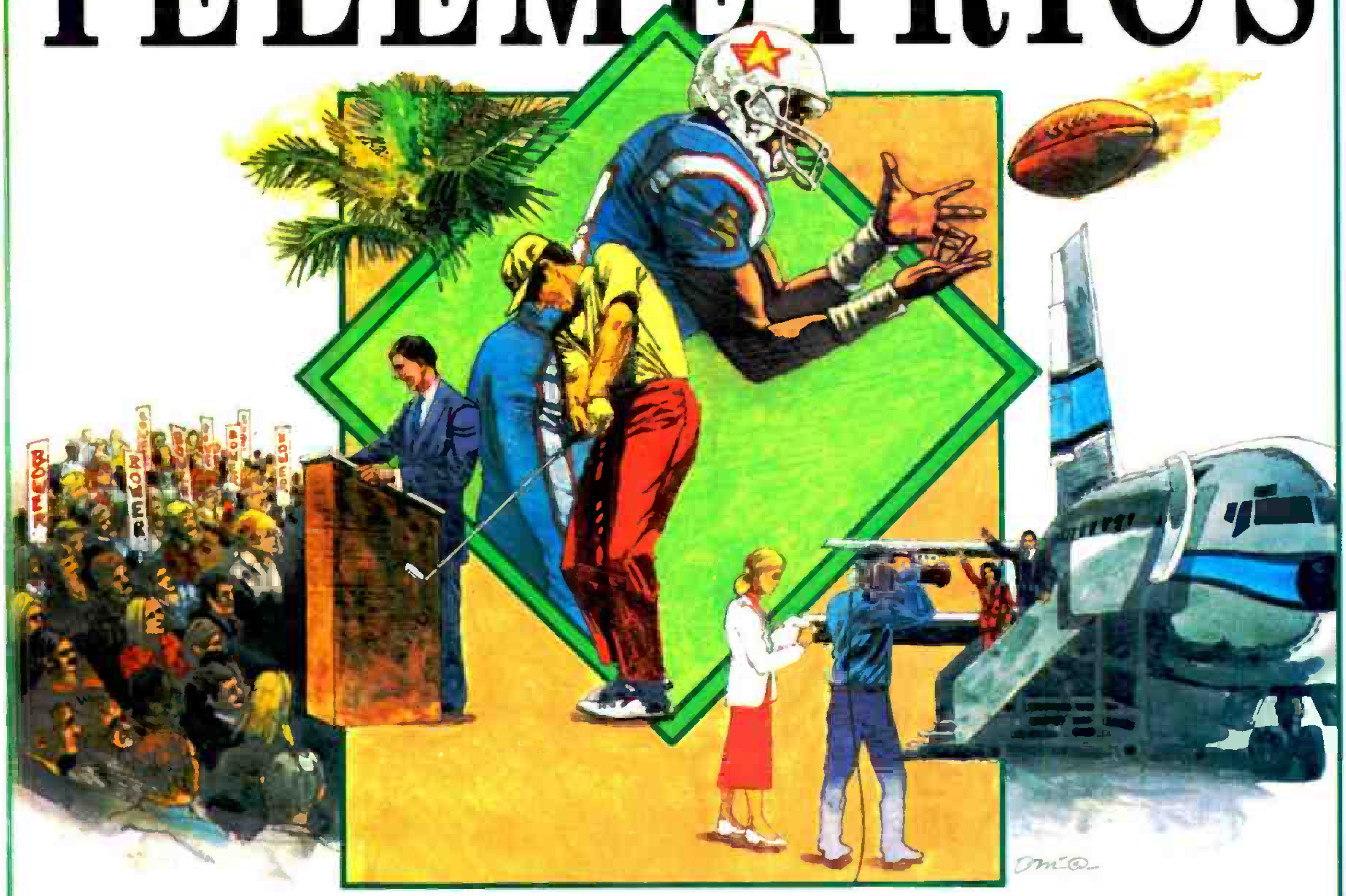

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instance, the technical director pulls the T-bar when the director says "take." Similarly, the decision to use one program segment instead of another generally falls to the producer, who in return may respond to directions from superiors.

The information flow in a broadcast station is not limited to the control room. Information from other departments also influences what goes over the air. Traffic, billing and sales departments provide important input, as does station management. (See "End-to-End Automation," April 1991.)

The value of considering these extended control points lies in making their influence more direct, hence more efficient. For instance, one chief engineer was recently commissioned to automate the traffic department. He rooted out several inefficiencies, leading to great cost savings. Other functions, such as personnel scheduling, budgeting and payroll, may be similarly investigated.

Training and manuals

The ability to use desktop computers is widespread. New employees will usually learn quickly how to use a PC that has been adapted to control station functions. Another advantage to using small computers is that they can contain diagnostic routines. Self-diagnostic systems can sense abnormal situations. When one occurs, the system may then indicate the cause, and provide suggestions to correct the problem.

A control room with many integrated devices should be equipped with manuals and procedures explaining how the equipment works and what to do when something fails. Some manufacturers supply their manuals on paper and in an electronic form. The latter can be retrieved on a desktop computer or workstation. The electronic manual is organized so that important information can be retrieved quickly when needed.

Computers can control multiple tape machines for automated recording and playback of incoming feeds. These systems also have application in network delay of broadcasts to accommodate time zones. (Photo courtesy of Time Logic.)

Digital difference

Digital signal processing systems transfer the broadcast information in digital rather than analog form. Digital interface requires unique techniques. This is because the bandwidths can be exceedingly high.

The most efficient digital link is probably the shortest one. Many manufacturers are now building complete broadcast subsystems that fit on PC cards. Installed in a computer chassis, the systems can generate special effects, perform titling, switch video and audio signals, and even edit tapes.

The station identifications for many radio facilities are now generated on such devices. Some of these systems offer advanced features, including the ability to synthesize either male or female voices. A new system for TV IDs stores audio files as extensions of the image file. The results are TV IDs that can be produced without slides, still-stores or audio cart machines.

Interface compatibility

It is difficult to interconnect equipment with either the equipment of other manufacturers or existing station equipment, unless such equipment follows standard recommendations. Therefore, many equipment makers incorporate the RS-422 interface in their equipment. The RS-422 interface has replaced the RS-232 interface in newer equipment, and complies with the SMPTE standard interface.

As the computing power available on the desktop increases, so does the potential role of the PC as a control tool. It really doesn't take that much computing horsepower to control a facility. Some experts feel the average 386 PC has plenty. (See "Implementing PC-Based Automation," April 1991.) However, harnessing that power may be a different matter.

Remember that any automation system is likely to suffer from unforeseen problems, especially in the beginning. The ability to override the automation system easily is important. So is redundancy, so other systems are available to take over whenever one system fails.

Network options

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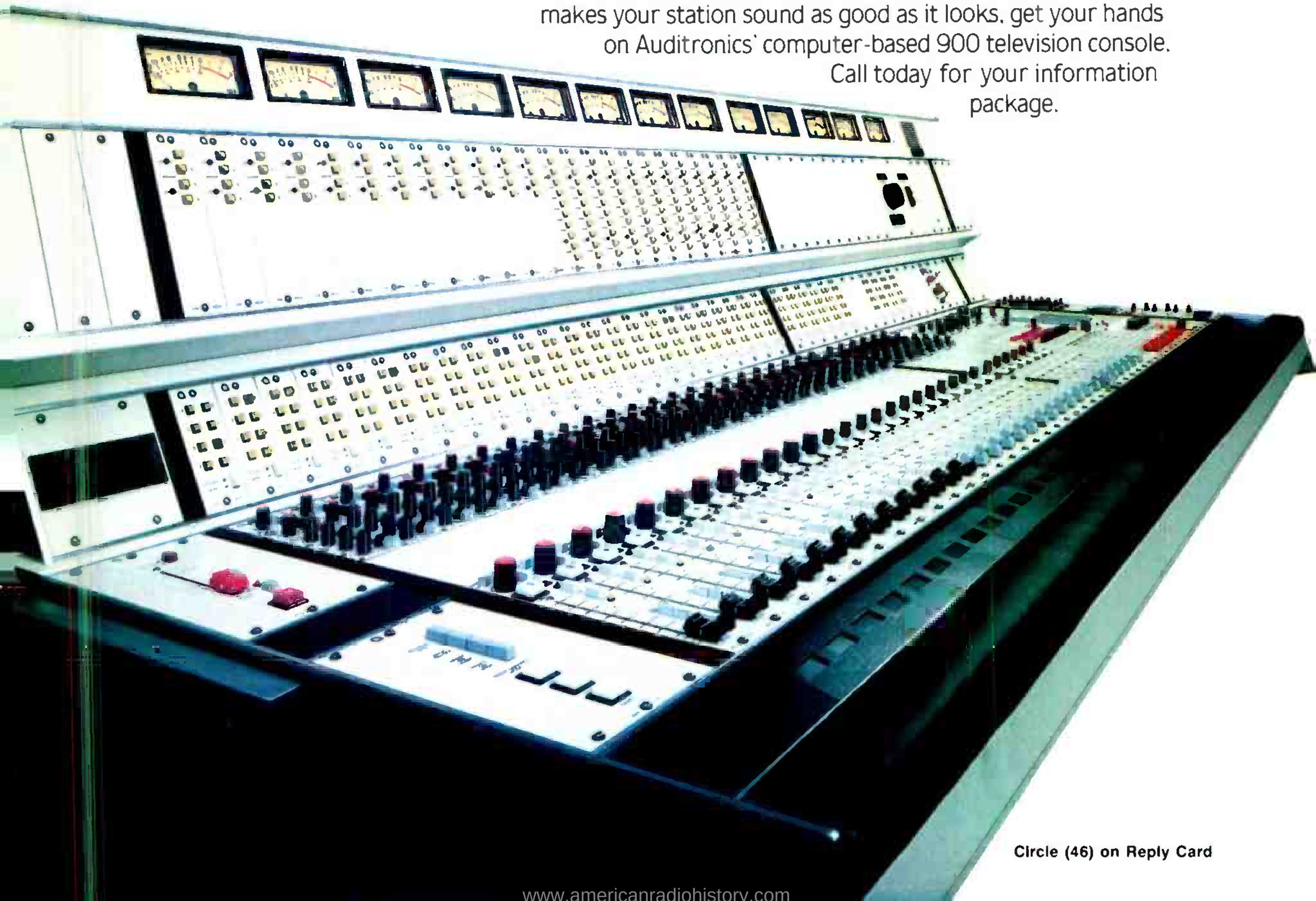

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may communicate with a number of workstations, or desktop computers may be connected in a local area network (LAN). The modem makes it possible for desktop computers in one location to communicate with desktop computers at the transmitter site or at other remote locations.

If a number of desktop computers are interfaced in your broadcast station, it may be necessary to assign different levels of authority to each desktop computer, depending upon what department it is located in and who uses it. Protection against unauthorized control should also be part of the control system. Most systems accommodate this by using systems of callbacks and passwords.

The ability of small computers to operate multiple tape machines has led to a new generation of editing systems. This user interface displays images from source and record decks, as well as giving visual representations of audio tracks. (Photo courtesy of Avid Technology.)

An economic issue

How far a facility may want to go in the automated control of equipment is a matter of economics. The facility is likely to have a large capital investment in equipment. Much of this equipment may have been around for years, and may work too well to throw out. Automating older equipment so it can be controlled efficiently may be one of the industry's biggest challenges.

The value of automation likely will depend on the cost of going without it. The station that can reduce costs by being more efficient will probably not be as motivated as the station that is taking a severe beating because of excessive makegoods. It may be desirable to replace some equipment that otherwise is in good condition, for no other reason than to improve control and automation. On the other hand, it may make sense to hold back on replacing older equipment that works well. In this as in so many areas, the bottom line is the determining factor.

Audio console automation for broadcast

By Brad Harrison

With the variety of automated systems working their way into many aspects of today's broadcast facilities (video cart libraries, routing switchers and newsroom systems), it seems natural for automation technology to arrive in the audio facility as well.

Audio console automation and the advantages it offers a broadcast facility have only recently come of age. Recording studios and video post-production facilities have been using audio mixing consoles with some form of automated assistance for more than 10 years. Until recently, however, most available systems were constrained in two critical areas that severely limited their use for live broadcast operations. First, most systems relied on a time-code reference. Second, most systems only controlled channel faders and muting.

In order for any form of automation to be useful in live applications, it must be able to work without any external time-code references, and it should offer more comprehensive control of console functions.

Harrison is Western regional sales manager for GLW Incorporated.

For automation to be useful in live applications, it must work without any external time-code references.

Special requirements of broadcast operations

In the recording or post facility, the engineer relies upon the automation system for making dynamic mix changes. The bulk of the operator's time is spent updating or fine-tuning these instructions until the proper balances and timings are achieved.

In contrast, the bulk of a *broadcast* operator's time is spent in preparing the console *setup* for a live production. Much effort is expended in arranging the routing for the main program feed and, in many cases, setting up complex and tedious mix-minus backfeeds to remote sites. Furthermore, a broadcast may include several different setups that cannot be completely preset before air, but only checked and noted for later resetting during the broadcast. This is especially true in large-scale programs when input or output buses must be reassigned while the show is in progress, because there aren't enough on the console to delegate separate ones to each source or output need in the broadcast. Typical situations of this kind might include election or other special-event coverage.

In live broadcast applications, everything is based on scenes or combinations of scenes. An automation system must work within these parameters in order to have any relevance and impact on the efficiency of live broadcast productions. It should allow the engineer to create and manage the complex audio setups that are frequently required today.

For maximum versatility, such a system should be able to operate dynamically, following one or more time-code reference standards, or in a "snapshot" mode in which preset configurations are instantly recalled by the operator when required during a live broadcast.

The bulk of a broadcast operator's time is spent in preparing the console setup for a live production.

Advantages of computer control

Designing such an audio mixing console automation system to operate within a desktop computer environment is also wise for operational and cost-effective reasons. Furthermore, the console-to-computer interface can be designed to use one of the popular high-speed databus systems used by these computers.

Ideally, in the "snapshot" mode, the computer should have the ability to "save" and control static console parameters, such as bus routing, input status, auxiliary send levels, audio processing settings (EQ and dynamics), panpot positions, channel muting and channel fader positions. An alphanumeric "slate" for each channel should also

be included, entered from the computer's QWERTY keyboard. Large quantities of these stored settings should be permitted without requiring excessive data storage, and recall/reset should be rapid.

In a dynamic mode, such static settings could be recalled from time-code locations (written "on the fly" in real time or assigned to a time-code address off-line), or full dynamic, real time control of all functions could be exercised, including sweeping parameters. In this respect, the system functions like a recording studio or post facility automated mixer, but preferably with control of all the previously mentioned operations.

Virtual vs. hard controls

The divergence of opinion that exists in the digital audio workstation world also comes into play for broadcast console automation. (See "DAWs Diversify," August 1991). If console control features (knobs, faders, switches and LEDs) can be displayed in an animated (virtual) control surface on a computer's display screen, this might eliminate the need for a large and expensive actual (hard) console. But for real time and non-automated applications, a hard console is still useful, if not essential.

A middle ground may be drawn, however, in which a large number of inputs and outputs may be accommodated in a mixing system, but without installing that number of actual I/O modules on the hard console. A hard module may be assigned to control and write automation data for a virtual channel. This saves console real estate and expense, but maintains the ability to perform moderately sized, non-automated mixing or live, hard console updating of recalled settings during a "runaway" broadcast.

> ***A system should be able to operate dynamically or in a "snapshot" mode.***

Module complexity and size can also be reduced by handling some functions, such as signal routing, in only the virtual display. Realistic graphics can minimize the disturbance to an operator of this new approach, and manipulation of these controls can be performed with a pointing device, such as a mouse or trackball.

Actual channel status and control settings can be fully displayed in real time on the screen for any channel. Processor settings could be displayed in an even more graphically representative fashion, such as a frequency response plot for EQ or an I/O transfer curve for dynamics processors.

However, any control change made by the operator using the virtual display must occur without delay, on screen and in audio.

Extensions

A supplementary element could allow editing of mix data so that static snapshots could be rearranged in sequence, different dynamic mixes could be merged, or individual control settings (such as EQ) could be "cut-and-pasted" or copied to another channel. Global setting changes could also be made in this context.

Finally, the system could extend its reach beyond the confines of the console itself to include external (but related) devices, such as a routing switcher, thereby allowing integrated (or stand-alone) control of signal flow to and from the mixer.

The availability, flexibility and cost-effectiveness of systems incorporating some or all of these concepts today makes their exploration worthwhile to any prospective audio mixing console purchaser.

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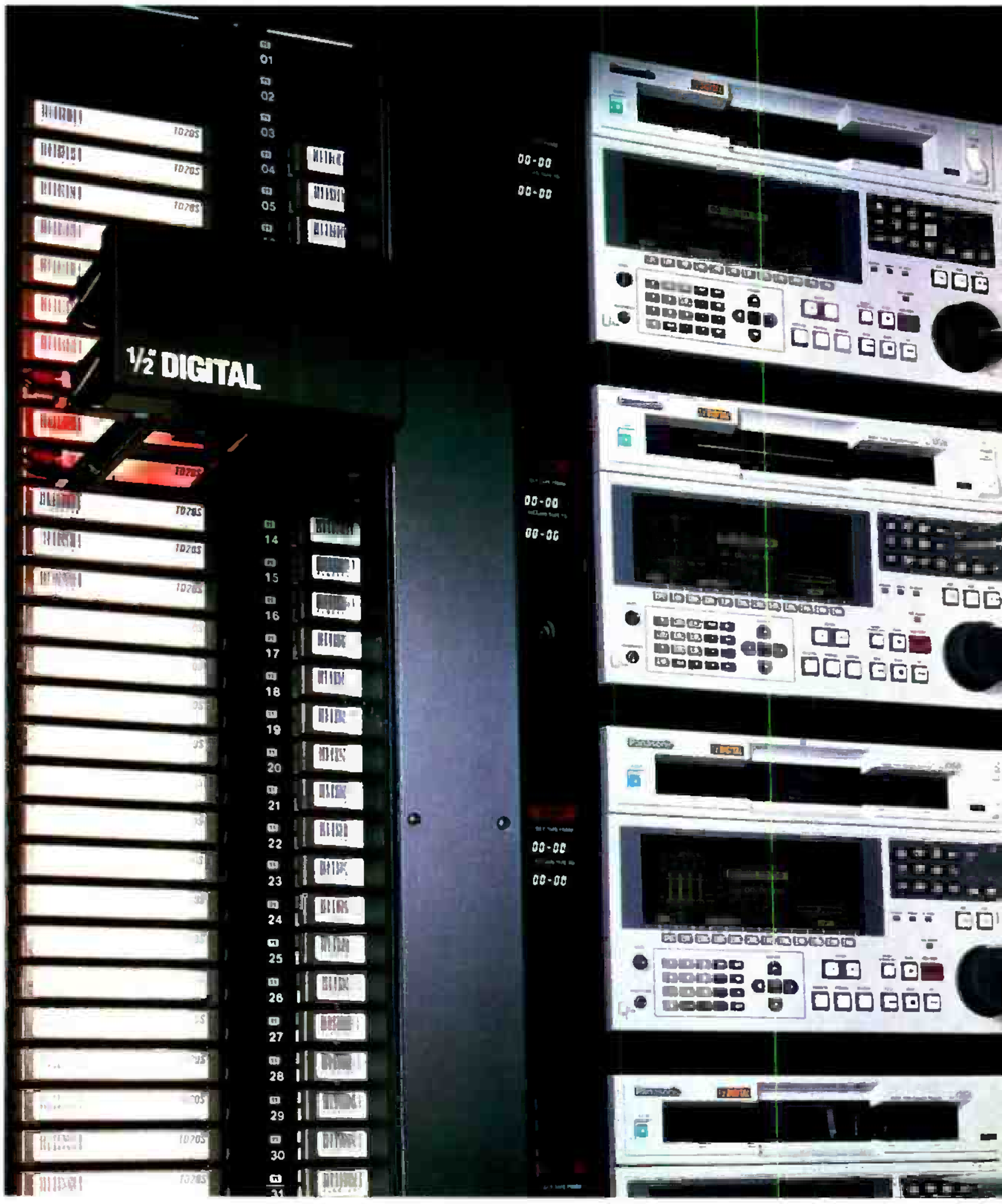

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Circle (53) on Reply Card

The on-line/off-line interface

The rapid growth of off-line editing systems is beginning to revolutionize the post-production industry.

By Bill Ferster

Instead of wasting time making editing decisions at expensive on-line facilities, more producers now edit off-line. They can then enter the on-line environment to perform the tasks they do best there — graphics, effects, compositing and titling.

Working off-line allows the editor to be creative without the financial pressure of the ticking clock. Off-line work also affords the luxury of editing multiple versions to see which one works best or to obtain approvals.

Using off-line facilities can decrease the cost and increase the quality of video production for broadcast. This article reviews some of the techniques used to move between off-line and on-line environments.

The nuts and bolts of off-line

The off-line process works as follows: First, the editor or an assistant logs the tapes. *Logging* serves two purposes: 1) It identifies good takes and footage; and 2) it links the good takes to their respective time-code numbers. Logging used to be a tedious process. However, a new generation of microcomputer-based products speeds the task considerably. Typically, these systems produce a data file with the time-code number shown in one column, and footage descriptions in another. The operator enters time code automatically by simply striking the space bar or a function key. The operator then types the description on the keyboard. The result is a neat, legible log that is produced quite rapidly. The time-code numbers may even transfer to some off-line systems. (See Figure 1.)

Following logging, an editor assembles a *rough cut*. Similar to a rough draft in the literary world, this first cut gives an idea of how the finished product will look. It also serves as a cross-check to make sure that all the needed material is usable and at hand.

After picking the shots, the off-line system produces its final output — an edit decision list (EDL). The system may also produce an edited tape good enough to use in some applications.

The next step is finishing in the on-line suite. Using the EDL and the original source tapes, the expensive equipment in the on-line suite re-creates the edits. This is an opportunity to use whatever digital effects, supers and elaborate transitions the on-line facility has to offer.

The EDL, placed in the hands of a good editor at a well-equipped facility, is the reason working off-line saves money. Developing an EDL in a low-rate off-line suite gives producers the chance to make their decisions before they come to the high-dollar suite. Furthermore, the off-line tapes can be submitted for approval before committing to the expense of an on-line version.

About off-line systems

An off-line system can be as simple as two VHS decks and a device that burns in time code. It can also be as elaborate as one of the powerful digital editors, which allows word processor-like manipulation of pictures and sound. Many systems fall in between as well.

Systems fall into two broad camps: those that use computers to control tape machines or disc recorders, and those that digitize and process video internally. The machine control systems are the most prevalent, although advances in the digital compression of video signals are making in-computer editing more cost-effective. (See Figure 2.)

Taking the EDL uptown

Regardless of how the EDL is created, the goal is to re-create the edits using the equipment in the on-line facility. Users must transfer the list of edits into the editing equipment used by the on-line facility. Because this process has become more commonplace, most experienced on-line facilities have gained considerable practice accepting lists created by various off-line systems.

Fairy fingers

Once the list is in the on-line system, the show can be "auto-assembled" with minimum operator attention, except for the changing of reels. This process can be simplified by paying attention to the order in

Ferster is president, Editing Machines Corporation (EMC), Washington, DC.

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which you direct the edits to be assembled onto the master. There are three ordering schemes. In the simplest, edits perform in the order they appear on the list. Typically, this is in the chronological order on the master. As each edit is performed, the editing system will instruct the operator to pop in the proper cassette.

A slightly more complex editing sequence performs all the edits on a given source reel in order to minimize the time spent changing reels. The most complex, yet fastest, method of assembly is to perform all edits in the order they occur on each source reel. This not only reduces time spent changing reels, but it also reduces search time.

Watching a program auto-assembly can be quite disconcerting — the show does not build chronologically. Edits are placed on the system in seemingly random order. The program emerges only in the latest stages.

TIME CODE			COMMENTS:
	SCENE:	3	
00:09:23:15	TAKE:	01	CHERYL STAND-UP (GOOD ONE)
00:10:24:22		02	WIND NOISE
00:11:25:25		03	TRUCK WENT BY
00:12:27:03		04	GOOD
	SCENE:	4	
00:15:32:07	TAKE:	01	CHERYL POINTS; PAN UP CAPITAL STEPS
00:16:33:28		02	SAFETY (FASTER)
00:17:34:12		03	OKAY
	SCENE:	5	
00:22:35:15	TAKE:	01	CHERYL IN GOVERNOR'S OFFICE (OKAY)
00:24:36:24		02	AUDIO PROBLEM
00:09		03	SLAMM

Figure 1. A sample printout from a tape logging system. Often, the scene and take numbers increment automatically. Time-code data transfers into the printout at the touch of a keystroke.

Sending it to the system

The EDL can be entered into the on-line system by one of three ways — typing it in by hand, reading it off a floppy disk or via a direct connection using a serial port.

Typing it in is the most tedious and error-prone means of transmission. Editors must work from a printed or hand-written list of the time-code numbers.

The most efficient way to transfer an EDL from the off-line system is through a floppy disk. To do this, the disk must be the proper size and format. Each on-line system has a unique format in which it will accept EDLs. It falls to the off-line system to produce a list in the proper language. Most on-line systems are capable of reading lists created in the CMX217 or CMX340

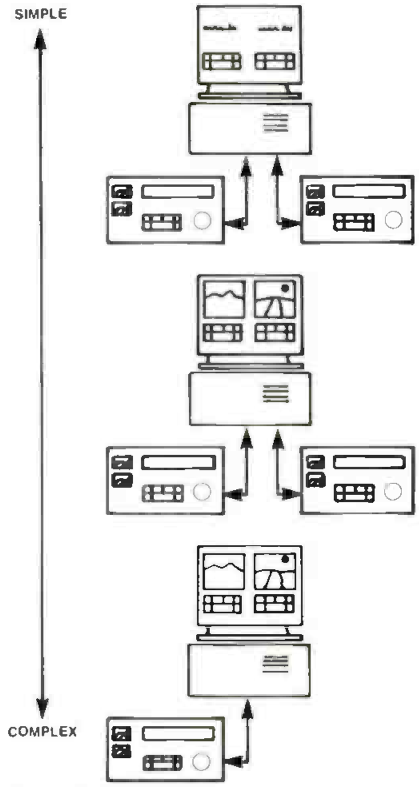

Figure 2. Different approaches to off-line system construction. The simplest systems use a computer to operate VTRs. More complex systems drive VTRs with a computer, but show a representation of the video on the computer screen. The most sophisticated and powerful systems digitize and process the video, or a compressed representation of it, in the computer itself.

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formats. It is best, however, if the EDL is prepared in a format that is native to the system. There may be some subtle differences, such as the ability or inability to use letters in reel names, which may cause confusion. Contact the facility to find out which formats its editor will read.

Older editing systems store EDL files on 8-inch floppy disks. This can be awkward and difficult, because 8-inch drives are not commonly available. More modern edit systems use the standard $3^1/_2$-inch floppy disks used on word processor computers, which makes interchanging much easier.

Different on-line systems require different disk formatting schemes. Do not confuse this with the EDL format discussed earlier. Three formats are commonly used — the CMX-RT11 format, used by CMX; the Grass Valley RT-11 format, used by Grass Valley; and the MS-DOS format, used by Sony and most other manufacturers. Most off-line systems have utilities for formatting and copying EDLs to disk in the correct format.

Sending it serially

If the on-line editor has no drives, or you are unwilling to purchase 8-inch drives to transfer EDLs at your PC, the EDL can be sent through a serial cable. The cable links the on-line computer, often at its paper-punch port, to the serial port of another computer that contains the EDL. Attempting this kind of EDL transfer can be a frustrating experience until all the bugs are worked out. But from then on, it is simple and quick.

A suitable cable must be obtained or built. Contact the manufacturers of the on-line system for a connection diagram.

The PC must contain a communications software package to transfer the EDL. Both the PC and the on-line system must be set up to transfer at the same parameters, such as baud rate, bits and parity. A baud rate of 1,200 seems to be the most reliable. Once communication is established, the on-line system is instructed to wait for an incoming EDL. The PC containing the EDL is instructed to send it to the system.

Building shows

Auto-assembly of shows created off-line can be a great time and money saver. There is a broad variety of off-line systems from which to choose. Using them frees editing personnel to concentrate on pictures and sound, not on moving VTRs.

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Archiving for productivity

New technologies make archiving productive and even profitable.

By Rick Lehtinen, technical editor

Two years ago, the governor of a neighboring state came to town and gave a press conference. He smiled for the cameras, then drank a big glass of local river water to demonstrate his confidence in the containment system at a defense plant located upstream in his state.

Five or six months ago, some local children brought in an unusual frog with an extra set of hind legs. They had found it along the river. A photographer shot the frog, and the piece ran as a parting shot in the late news one night.

On a hunch, the photographer introduced the children and their frog to his wife, a biology instructor at the community college. She was shocked. The next weekend she took her husband on a "fishing" trip and they gathered water specimens from up and down the river around the plant. It took awhile to perform the analyses, but the preliminary results strongly implicated the plant.

Last week, a correspondent working a different story chanced upon an unreported business relationship between the governor's brother and the plant.

Sensing he was onto a story with Murrow award potential, the news director pulled out the stops. He watched over each phase of the project personally. He planned to break it in a big way the following week, at the start of the sweeps.

Things went well until this morning. The photographer's wife called to say her department head had told the Dean of Instruction about her field trip — and that she now was locked out of the lab and had been instructed not to talk to anyone about her findings. She was told they would call a press conference in a few days. Until then, she had to keep quiet or lose her job.

All fury broke loose when the news director got the word. The deadline changed to that night. He wanted the scoop badly, and he saw his chance slipping away. He knew that the dean was a close friend of a reporter at a rival station.

Because the governor's visit occurred the same day one editor's son was born, there was no trouble finding the date and locating his footage. But what to do about the gagged scientist? He would need the frog footage, but that producer had since quit the station and moved away. The needed video was somewhere on a shelf containing 60 cassettes. To shuttle through them all would be futile, because there was not enough time.

*The news director was furious, "I will not lose this story because you clowns can't find some footage of that *$%@ frog! I'll hire a staff that can!"*

No one likes to miss an opportunity because something couldn't be found when it was needed. In a fast-paced business, such as news, quickly getting your hands on a critical item may be a job-saving skill. But footage is hard to file. Each broadcast covers so many topics that newscasts become difficult to catalog. Without catalogs, archives are useless. As a result, facilities may miss many chances to enhance the interest and value of their news programming — or to save a big story when the unexpected happens.

This article will describe how some new technologies can help stations get top value from their archives. By making some moderate investments, facilities can quickly and easily find anything they have on file.

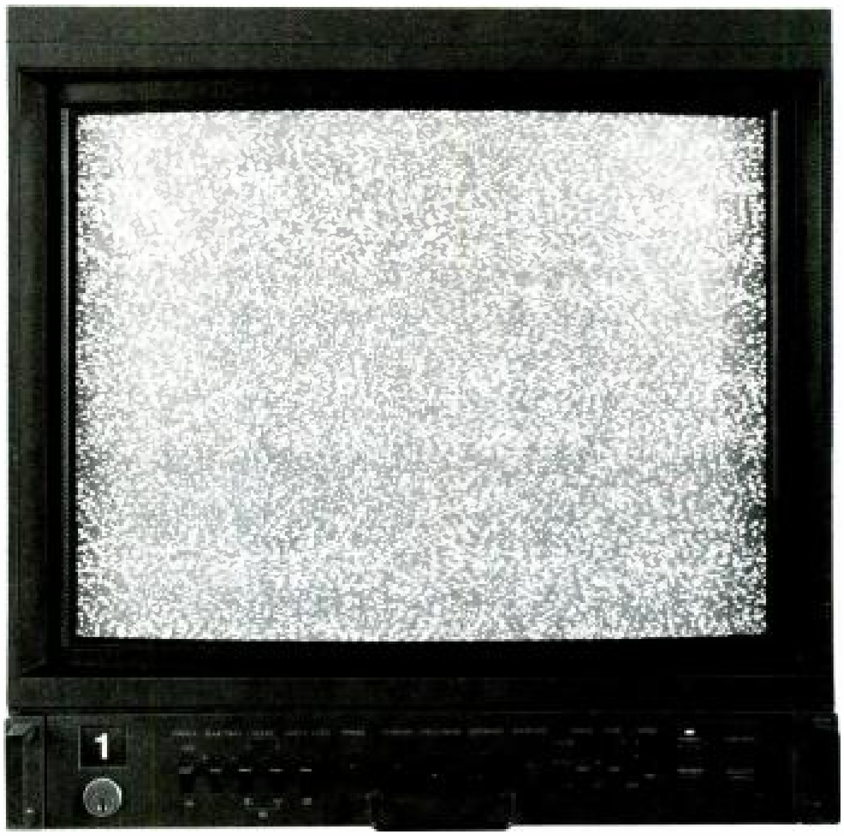
Meet the culprit

The problem of archive management, at its root, is the cryptic nature of videotape. Unlike a piece of film, you can't tell anything about what's on a tape by direct examination. Furthermore, all cassettes look pretty much the same. Even if tapes are uniquely identified with reel numbers, this gives no clue as to their content.

A felt tip pen can be beneficial. If you write "Noon news, July 25, 1991" on the reel, it will give you some idea about the tape's contents. However, this merely categorizes the contents, it doesn't declare them. There needs to be a way to describe accurately what's on the tape, like a magazine's table of contents. Such labels are available, but in high-pressure jobs and times of tight budgets, who is going to fill them out? So, the archive remains a wasteland.

New direction

Stations can turn the corner on archiving when the staff adopts the view that archiving is a productive activity, not a chore. Think about it — all the footage in



an archive has been bought and paid for. The shooting and editing are finished. In the case of newscast archives, the material has all been copyrighted and has passed the critical test of having been made public. (Many stations refuse to archive field tapes, because off-the-record comments and activities of taped individuals may present liability problems if inadvertently used later.)

After establishing the value of the archive, the problem remains in finding the right contents in it. Laboriously creating detailed labels — if it gets done at all — may be unsuccessful, because the descriptions will probably be inadequate. Too many stories will have similar names or slug lines. Also, it will be hard to search the archive by subject. This is an important capability. It allows the archive to contribute ideas, not just footage.

Perhaps the key to unlocking a news archive is realizing that the tapes are merely picture and sound representations of the underlying news stories. If you search the scripts, the tapes will follow.

Newsroom computers

This highlights the importance of a computerized newsroom. Not only does it enable reporters to rapidly incorporate information from many streams, such as national news wires, it also simplifies pulling in items from the past. The computer simplifies the search backward through time, combing through mountains of old scripts effortlessly.

Again, users should ensure that their systems can search a script archive by subject. This increases the reporter's access to materials, compounding the archive's value.

Some newsroom systems provide this capability, using keyword searches and other techniques. Other systems may need add-on hardware that is currently available. Fortunately, this is the age of personal computing, and such add-on systems do not need to be terribly expensive.

Electronic picture file

Effective search routines may locate desired text information, but how can a user quickly examine the footage that accompanied the script? After all, it takes time to shuttle through a box full of tapes. Computers can help once again. New technologies make it easy to store a representation of the archive video in a rapidly accessible format. One PC-based system uses a recordable laserdisc player to store one frame of video every few seconds. Program audio is stored in its entirety. The system uses a digital compression process that writes audio data to the disc as a video signal. Stored this way, a year's worth of newscasts fit onto two or three discs. (See Figure 1.)

In use, the operator scans the script archive using powerful keyword searches. A list of slug lines containing the keywords comes to the screen. Scanning up and down with the arrow keys, the operator can select one that seems likely by touching a function key. The script segment then pops into view, with the keywords highlighted. If the segment isn't right, the operator returns to the previous screen and picks a new slug line. If it looks promising, the operator touches a second function key, which accesses the laserdisc and plays the segment. This may give the operator all the information that is needed. If a reporter then wishes to use the story footage in the present piece, the tape can be fetched from the archive.

In the future

In fact, the time is approaching when newscast pictures and sound will merely be special extensions of the basic script

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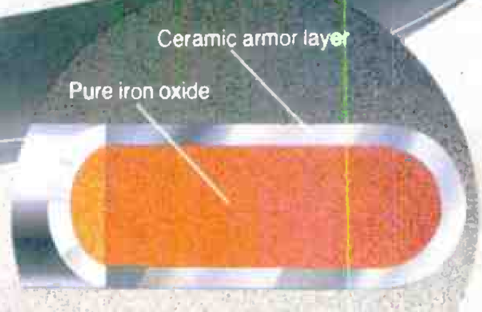

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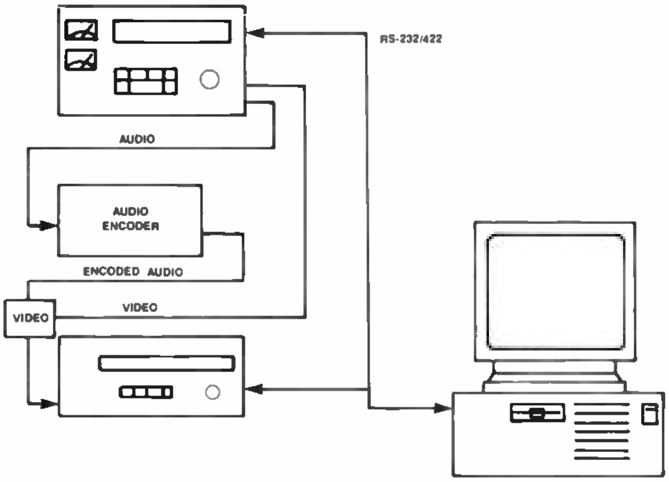

Figure 1. *One archiving system transfers a representation of taped material onto a laserdisc recorder for archive use. Operators can search a script archive using keywords. They can then call up the laserdisc version of the story to see if it meets their needs before pulling the actual tape from the archive.*

file. Editing and manipulating the pictures and sound may become a process akin to word processing, and use the same equipment. Working a good visual into the story will be a writing process similar to working in a good quote. In computer jargon, this process is called *multimedia authoring*.

Mining operations

Such systems can make the archive accessible from the day they are installed moving forward. Also, it isn't hard to build archive discs moving backward to the earliest point at which scripts were computerized. But what about pre-existing archives, or cataloging material on tapes for which there is no script? Is there a way to determine what is on a tape and make that information useful in an expedient fashion?

Fortunately, yes. A new family of *tape loggers* allows users to quickly list the contents and time-code numbers of a tape by hooking up a VCR to a PC. (See "The On-Line/Off-Line Interface," p. 78.) The data files created by these systems can be imported to many archive systems.

A second development is the use of PC-based systems to track the location of tapes, as well as keep a detailed log of tape contents. One such system uses bar code labels to identify each tape. Operators scan the tapes in and out of storage locations. This way, when a given tape can't be found, it is easy to learn who had it last and where. Such systems are also useful for controlling the inventory of new tapes. (See "Automated Station Libraries: A Systems Approach," April 1991.)

As archives increase in their newsworthiness, it is likely that more new products will appear to help news entities make good use of them. Hopefully, such technology will increase the productivity of archiving, and will appease even the sternest news directors.

Acknowledgments: The author wishes to thank A. Owen Smoot, KSL-TV Advanced Technology Group, Salt Lake City; and Irene Nesbit, Nesbit Systems, Princeton, NJ, for their help in preparing this article.

B-rolls

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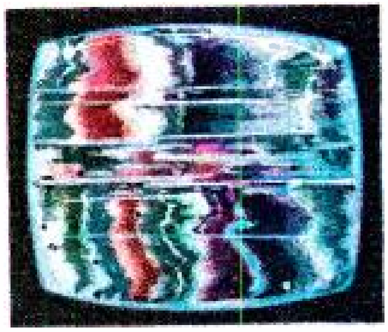

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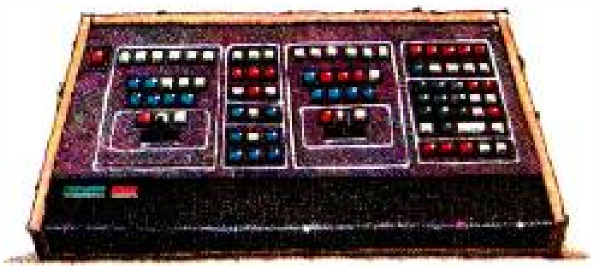
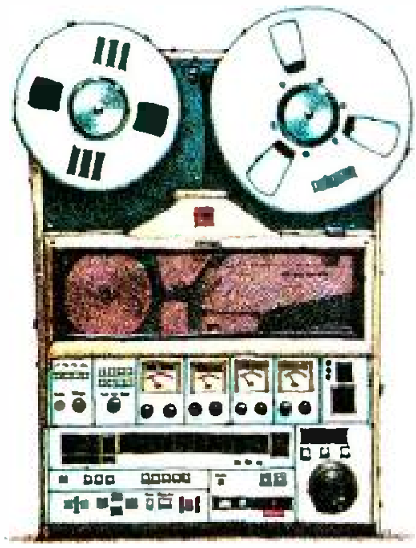


Separate Edit Controllers



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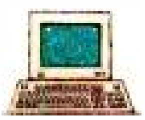

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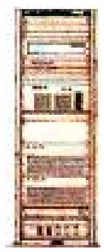

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SBE show preview

SBE convention convenes in Houston.

By Skip Pizzi, technical editor

Broadcast technology will launch into a new and critically important era at the 1991 SBE National Convention and *Broadcast Engineering* Conference, Thursday through Saturday, Oct. 3-5. Houston, dubbed "Gateway to the future of technology," is a fitting site for broadcast engineers to take a long look forward at the many changes in store for their industry.

More than ever, technological change is dramatically affecting the careers of broadcast personnel. Therefore, anyone involved with broadcast technology today is likely to find something of significant value at this year's conference.

Beyond the overall assessment of the current state of broadcast technology and regulation scheduled for the first day of the conference, specific subjects to be explored and updated during the rest of the program include frequency coordination, radio and TV RF systems, digital radio, facility automation, problem solving and new technology for radio and television. Two special evening sessions will cover the topics of "Audio Processing in the Digital Age" and "The Upward Engineer."

As usual, the exhibit floor hours will not overlap with the conference presentations. But this year, the exhibit floor adds an extra hour in the afternoon, opening from 10 a.m. until 4 p.m. on Friday and Saturday, Oct. 4 and 5. There will also be plenty of time to meet with colleagues at Thursday evening's exhibitor-attendee reception, Friday's ham radio reception (with its traditional door prizes) and Saturday night's reception and banquet. Congressman Don Ritter (R-PA) will be the featured speaker at the banquet. He is a member of the House Energy and Commerce Committee, and its subcommittee on Telecommunications and Finance.

Conference sessions and exhibits will be held at the George R. Brown Convention Center, one of the country's largest and most highly regarded venues.

Ennes workshops widen scope

As in the past, a number of special workshops will be conducted under the auspices of the Ennes Foundation on the day before the conference begins. (The Ennes Foundation is an arm of the SBE that is devoted to the continuing education of broadcast engineers. It is named after Harold E. Ennes, author of many widely used broadcast texts.) For a small additional fee, conference registrants can attend these morning or all-day sessions, and gain detailed insight or hands-on training in a specific and intensive manner.

A record-setting slate of 12 separate sessions are tentatively scheduled for the Ennes workshops, presented by respected manufacturers and consultants. Among the topics offered are TV facility automation, fiber optics for video transmission, newsroom automation, becoming a contract engineer, low-power satellite uplinking, frequency coordination, engineering team-building, video and audio TV measurements, digital radio broadcasting and various RF sessions.

Because technology is not the sole province of engineers and vice-versa, two of the Ennes workshops this year offer a special "cross-pollinating" feature. For each fully registered engineer attending the newsroom automation workshop, a free pass will be issued for that station's news director to also attend the session. Correspondingly, for each engineer enrolled in the digital radio workshop, the station or general manager may attend that session free.

All workshops will be held on Tuesday, Oct. 2, and seating is limited. Continuing education credits (CEUs) and workshop completion certificates will be awarded.

Extracurricular extras

Houston, nicknamed "Space City," is the home of The LBJ Space Center, the facility that serves as mission control for NASA, and the place where America's astronauts are selected and trained. Tours of the facility (including its collection of moon rocks and historic spacecraft) will be conducted for SBE attendees on Wednesday, Oct. 2, and Thursday, Oct. 3, from 1 p.m. to 4 p.m. on both days. Registration for the tours is limited, and will be conducted on a first-come, first-serve basis. (An additional fee will be charged for this tour, which includes round-trip motorcoach service between the Convention Center and NASA.)

Tours of the well-known Senior Road tower facility will also be conducted by SBE, free to paid convention registrants. The site features a 9-station FM combiner system, and is the only such facility putting this many full Class-C (100kW ERP) signals into a single antenna. This tour will also make a stop at the Houston International Teleport. It will be conducted on the same schedule as the Space Center tours.

Houston is the fourth largest city in the United States, and it offers much in the way of cultural and shopping opportunities. A fun-filled spouse/guest program takes advantage of this, offering two full days of activities (Oct 3-4).

SBE '91 will provide information, education, conversation and fun — all of the ingredients for a worthwhile and memorable convention not be missed.

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SMPTE show preview

SMPTE to celebrate 75th anniversary in Los Angeles.

By Rick Lehtinen, technical editor

The 133rd SMPTE Technical Conference and Equipment Exhibit will be held in the Los Angeles Convention Center from Saturday, Oct. 26 to Tuesday, Oct. 29. SMPTE will celebrate its 75th anniversary at this conference. To mark the event, SMPTE will release a commemorative book, *Milestones in Motion-Picture and Television Technology: the SMPTE's 75th Anniversary Collection.*

Exhibitionist tendencies

This year, 200 companies will display their equipment and services. SMPTE equipment exhibit hours are Saturday, Sunday and Monday, from 10 a.m. to 6 p.m. and Tuesday, from 10 a.m. to 4 p.m.

SMPTE is again offering free use of the successful New Product Introduction room, a place where exhibitors can hold press briefings and private showings for special clients. Last year, 16 companies took advantage of this service.

Papers and tutorials

The conference theme is: "Advanced Motion Imaging — Enhancing the Universal Language." One hundred and twenty-nine papers will be presented in 15 sessions.

Digital technology is the key to enhancing the image for television and film. Three sessions will cover the digital world, from recording to processing and transmission. A morning session on advanced television will feature a discussion on proposed advanced TV systems from around the world.

There will be two concurrent sessions held every morning and afternoon, with the exception of Monday afternoon, when there will be three. The sessions and the exhibit will conclude Tuesday afternoon.

Equipment exhibition hours:

Saturday-Monday, Oct 26 to 28:
- 10 a.m. to 6 p.m.

Tuesday, Oct 29:
- 10 a.m. to 4 p.m.

This will allow conference delegates to participate in SMPTE engineering committee meetings on Wednesday, without schedule conflicts.

A special tutorial session will open Friday, Oct. 25. This all-day event will include demonstrations and presentations on the interface of film, video and computers.

Hands on

The society is expanding attendees' learning opportunities by adding three hands-on workshops to the program: "Bar Code in the Workplace," "Television Test Signals and Equipment" and "Computer Graphics." Participants in the 2- to 3-hour sessions, which will be held Saturday and Sunday from 2:30 p.m. to 5:30 p.m., will have opportunities to update their skills.

SMPTE® 1916 1991 75th ANNIVERSARY

The focus of these workshops will be on equipment already in use, as opposed to the prototypes discussed in the technical program.

Honorables to be mentioned

At the opening session on Saturday morning, standards-advocate Roland J. Zavada (retired from Eastman Kodak) will present the keynote address. Zavada's standards efforts have spanned many years and many national and international organizations.

Individuals who have made significant technical contributions will be recognized at Saturday's honors and awards luncheon. Twenty-two people will be recognized at this event. Academy Award winner Gregory Peck is the luncheon speaker.

Fifteen new Fellows of the society will be inducted at the Fellows luncheon on Sunday. Fellows, by their proficiency and contributions, have attained an outstanding rank among engineers or executives in the motion-picture, television or related industries.

A spouse/guest program will include four days of sightseeing, shopping and cultural outings.

Registration

SMPTE is offering a money-saving plan to register for various combinations of events. This can include the technical program, equipment exhibit, tutorial, workshops and honors and awards luncheon. By purchasing one of these combinations, registrants can save up to $50.

All registrants are invited to an exhibitor-sponsored party on Friday, Oct. 25, to celebrate the SMPTE's 75th anniversary and to preview the exhibit before it opens.

Looking for a function generator with all the bells and whistles,

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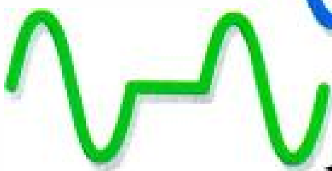
arbitrary waveforms,

and modulation,



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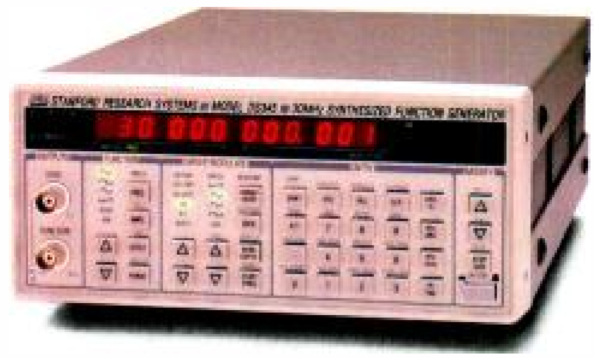

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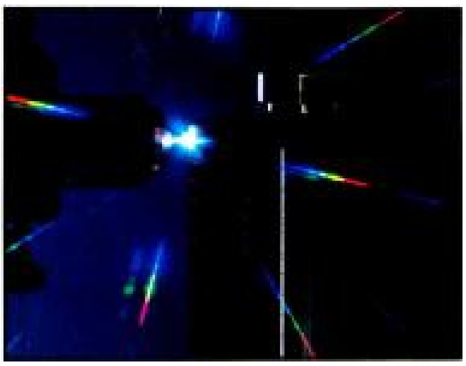


Affordable digital audio processing

By Jim Ruse and Dave Landar

Digital audio processing requires extensive computational power, which makes it difficult to bring economical and flexible processing to the professional audio industry. A worthy goal, then, is the development of a digital audio processing engine that would be configurable for many industry needs. For example, it must be expandable to meet the requirements of a specific implementation, and it should not become quickly obsolete. This article will discuss some of the design criteria that must be met in order to create such an affordable digital audio processing engine.

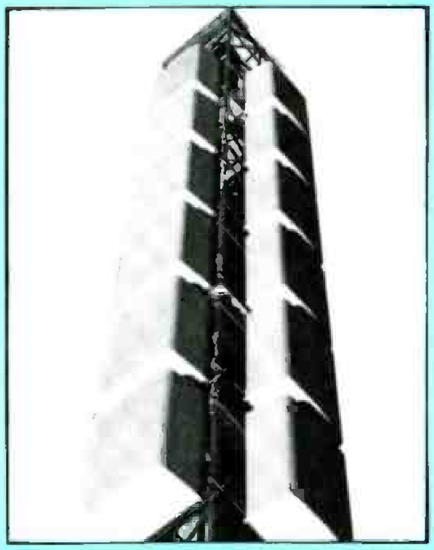
Ruse is product development and marketing manager, and Landar is vice president, research and development, for Audio Animation, Knoxville, TN.

The simple development of this engine is not enough to make the technology usable. It must also have extremely efficient digital signal processing (DSP) software, and a user interface that is intuitive, elegant and powerful. In February 1990, a team of developers at Audio Animation established two goals: 1) to create a configurable, expandable, distributed processing hardware platform using multiple DSP chips, and 2) to develop ultracompact processing software, both within a flexible graphic user interface (GUI). The first implementation of this engine for broadcast systems has been completed, under the trade name *Paragon digital audio transmission processor.* This engine will serve as the core technology for a series of future products for other elements of the professional audio industry.

New hardware development

Development of the hardware that would deliver the computational power necessary for digital audio processing involves the leading edge of today's computer science architectures. A distributed processing architecture maximizes the power of multiple DSP chips at all times with a technique called systolic wavefront processing. The Paragon hardware employs a proprietary implementation of this technique.

Systolic wavefront processing can be compared to the human circulatory system. Each DSP chip is completely efficient



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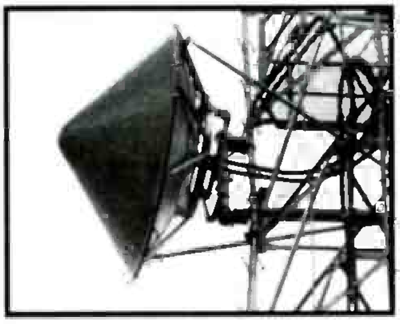

Standard Solid With Radome

in its own task during a given time frame or "beat of the heart." Each DSP chip completes its tasks as quickly as possible. If the task is too great to complete within the time allotted, it is subdivided and distributed to other DSP chips that have the available power. Within each 44.1kHz clock cycle or beat, the entire system may be reconfigured, and the processing tasks may be redistributed so that no processing power remains unused.

In some parallel processing engines, the processors waste a relatively large portion of time waiting for communication of data to or from the next processor. Placing special VLSI chips between the processors reduces the data transfer time to zero, and allows the DSP engine to have a minimum of hardware associated with interprocessor communication. In fact, the California Institute of Technology and Intel have co-developed what's reported to be the fastest computer in the world (the Delta) using a similar architecture. The implementation under discussion here, however, is more suited for digital signal processing, and does not have the massive RAM necessary for supercomputing.

The DSP engine is configured for transmission processing by using multiple Motorola 56001 chips and several proprietary VLSI chips. (See the February 1991 cover.) Because the systolic wavefront processing architecture is not processor-specific, a different DSP chip may be used to accommodate specific implementation needs, such as the Texas Instruments C30, which provides floating point computation.

New software development

Software efficiency is directly related to the amount of hardware necessary to complete processing tasks. Special implementations of digital audio filters and dynamic range controllers are important to success in a configurable, cascadable digital audio processing platform.

Ultrahigh resolution of the audio processing is a critical goal, and should not be sacrificed for code size. With the correct DSP filter and dynamic range controlling software, such a digital implementation has many applications beyond broadcast audio transmission processing. This technology could be implemented into devices appropriate for any audio studio, post-film or video suite, including fully digital mixing consoles with extensive equalization and dynamic range control.

There are also further applications outside the audio industry. After development of the hardware and software systems, the total configuration of the broadcast industry device was determined. Figure 1 shows the signal architecture of the multi-DSP engine, as configured for audio transmission processing.

All blocks in the signal path may be disabled by the user except for the peak-

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*4X series: w/o control panel; subject to change.

More reasons... *Anyone* can learn to use an *AutoPatch* in minutes (they're about as easy to understand as an intercom); an RS232 port is included for interface with any serial data device (eg: microcomputers or touchscreen controllers); the new 4YDM series has signal specs suitable for pro audio applications, high speed data, and for both composite and component video systems.

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4XDM optional control panel face illustrated

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controlling limiters. The selection of 4-band compression and 4-band limiting was based on the need for low intermodulation distortion (IMD) characteristics. The 4-band operation of the compressors or the limiters may be separately adjusted to act as wideband compressors/limiters. The four bands of each stage also may be adjusted to be partially coupled, which yields some interdependence between the bands' gain reductions.

Crossover frequencies between the bands are continuously variable with resolution to 1Hz. Attack, release, compression ratio and output mix level controls are provided for each of the compressor bands. The limiter bands have controls for release time and input gain, which controls the amount of limiting in each band. Pre-emphasis filters and final 15kHz low-pass filters are placed before the multiband limiters. (See Figure 1.)

System control

The main controller for the system is an 80286-based PC board that handles administrative, graphic, disk I/O and front-panel tasks. The PC board uses one slot of the custom backplane, which may accommodate up to 12 DSP cards with two DSP chips each, various I/O cards and the optional digital stereo generator card. The analog-to-digital and digital-to-analog converter boards may be populated for 16- or 18-bit resolution. It uses delta-sigma conversion, then FIR filters and decimation to achieve the desired specifications.

The system was designed to detect a failure in any processor. If a failure occurs, the system brings another processor on-line, loads it and continues full service. Similar self-diagnostics are present in the front-panel microcontroller, which can report its own failure to the PC.

Graphic user interface

Control of all parameters of the processing system is centralized and displayed on a 9-inch VGA monitor behind the front panel with a resistive touchscreen.

The video touchscreen was chosen as the control surface for its "virtual reality," the *display* of controls on a screen rather than the actual physical knobs and buttons

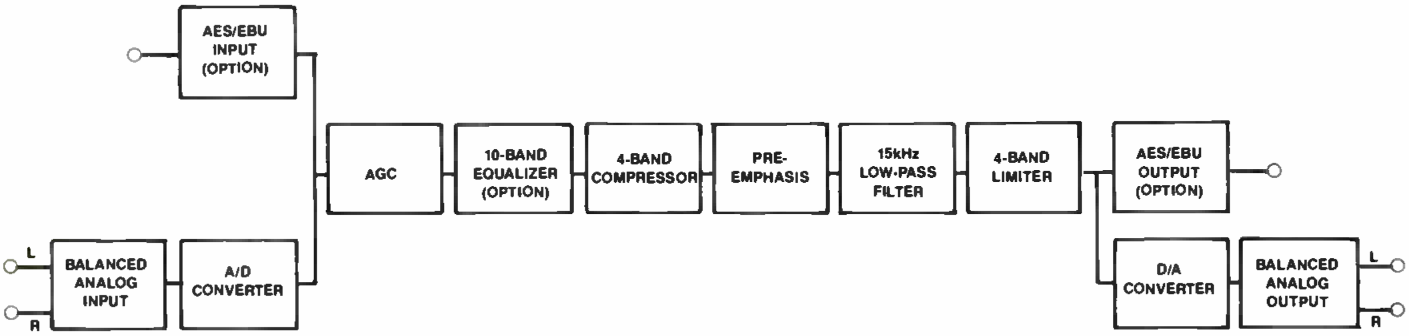


Figure 1. Block diagram of Paragon digital audio transmission processor, including all optional functions.

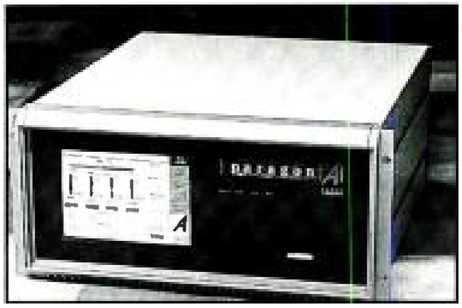
on a panel. If a modification or update that requires a new control knob is needed, no physical changes to the front panel are required. The new software is installed via a front panel, 3.5 floppy disk drive. The new knob, or function, will not be displayed. Such a control surface provides many different screens, which saves front-panel space and the cost of physical controls. Theoretically, "virtual reality interfaces" allow one visual display, such as a CRT, to show an infinite number of screens and controls, while retaining the easy-to-use, intuitive nature of analog controls.

A distributed processing architecture maximizes the power of multiple DSP chips at all times.

Another advantage of such a display of data and controls is that the user understands the system more rapidly. Full-screen context-sensitive help windows may also be accessed at any time. To adjust a parameter, the user touches the appropriate knob displayed on the screen, then turns a large physical knob to the right of the screen to change the value of the selected control. If the control is a button, then the parameter toggles to the next value. If the value is considered critical, such as input level or pre-emphasis curve selection, then a confirmation message is displayed to ask the user if he or she truly wishes to change this parameter.

The graphic user-interface software was developed in conjunction with several chief engineers and program directors who paid careful attention to the creation of intuitive controls. Each screen displayed on the monitor has a specific grouping of controls. The main screen allows adjustment of overall compression, overall limiting, release times of each compressor band, and the output mix of the compressor bands. These parameters give the user control of the basic tonal balance of the audio and the "density" of the sound. To get more exacting control, the attack times, release times, compression ratios, crossover frequencies and interband side-chain control may be adjusted on the detail screens.

Engineering adjustments are grouped on the setup screens, which control pre-emphasis, input/output levels, L-R metering, password control, AGC gate threshold, AGC defeat, stereo strapping of the compressors/limiters, pilot injection, composite level and more.



Front panel of Paragon digital audio transmission processor, showing the touchscreen control panel at left.

Options and advantages

The systolic wavefront processing architecture, as implemented by Audio Animation, will allow extremely efficient use of DSP hardware. Development of the hardware as an engine and the software as the specific tool allows for easily installed revisions and remote-control options. Reduction of hardware requirements increases reliability and serviceability, and lowers the final cost to everyone.

Extended switcher features

By Abekas Video Systems

• **A84 integrated cache recording:** combines disk recorder with switcher for 60s duration real time 4:2:2 video storage on four disk drives; provides enhanced speed and precision in video composite development; system also allows random access to 100 full bandwidth still images.

Circle (351) on Reply Card

Digital video effects

By Abekas Video Systems

• **A57 effects:** based on A53-D operating system with all processing in digital domain; includes integral key channel, true 3-D rotation, perspective, corner pinning, solid builder features; 10-bit frame-based processing using 8-bit dynamic rounding; various input, output options.

Circle (352) on Reply Card

Loudness controller

By Advanced Communications International

• **AudioBOSS I:** unit maintains a consistent audio level in systems where sources with varying outputs may be switched into the audio path; designed for use with audio (commercial) insertion systems; includes 15dB noise-reduction circuit and compensates for audio peaks.

Circle (353) on Reply Card

HD video monitors

By Barco nv

• **HDM 2081:** 32-inch medium-resolution CRT in multiple standard high-definition monitor; 16:9 aspect ratio with slot in-line CRT and DAF gun structure; accepts tri-level sync signals of 1250/50, 1125/60 and 1050/59.94 HDTV standards; 30MHz bandwidth; dual inputs definable for RGB or component; compatible with CVM/CPM auto setup probe.

Circle (356) on Reply Card

Video conversion

By Tektronix/Video Products

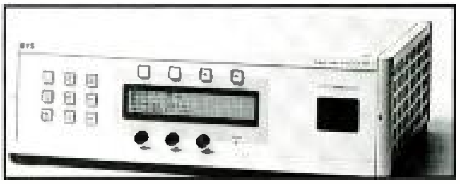
• **Avanzar video system:** encodes silicon graphics workstation signals to studio-quality video in real time; multiple output formats include CCIR-601 4:2:2, D-2 parallel and serial, analog RGB, Betacam, M-II, S-Video and composite NTSC and PAL; ChromaMetrix feature verifies that signal conforms to broadcast standards; input compatible with TIFF, GIF, Targa, RGB, YUV file formats.

Circle (377) on Reply Card

Digital video processing

By BTS Broadcast Television Systems

• **Model M NR 9:** median noise reducer; suitable for film grain reduction; dual frame buffers serve as recursive filter and infinite synchronizer/TBC; full 4:2:2 architecture with 10-bit data path; image position adjustment in H and V relative to reference input.



Circle (358) on Reply Card

Video image store
By Rank Cintel

• **Slide file duette:** 2-user version of Silhouette still-store system; shared access to library for edit user and program user; polyphoto cataloging technique; edit user prepares stills and sequences with access to effects capabilities; removable disk or streaming tape archiving; compatible with Logica Gallery database stills libraries.

Circle (372) on Reply Card

Reference monitor speakers
By Westlake Audio

• **BBSM series:** redesigned product with crossover network for improved phase alignment and control of audio characteristics; nine models in series range from two ported 4-inch active woofers with ¾-inch dome tweeter to a system with two 15-inch woofers, 10-inch midrange and 2-inch tweeter.

Circle (380) on Reply Card

Edit bay speaker
By TGI-Tannoy

• **Model CPA 5:** speaker systems using inductive coupling technology (ICT) 5-inch dual concentric driver with high-frequency passive radiator; a 1-inch Duralumin HF dome excited inductively by the low-frequency unit; phase coherence, time alignment for true point source system; for edit and post-production suites.

Circle (378) on Reply Card

PAL signal sources
By PESA Electronica

• **Model VG6140:** 12-bit digital architecture PAL sync, test pattern generator; numerous patterns access from front panel with three user-presettable memories; digital gen-lock referenced to black, composite video or composite sync; correct SC/H phasing.

• **Model DG6250:** video pattern generator produces two PAL analog outputs without 25Hz offset; 50-pattern EPROM accessed from front panel; LCD display indicates selected pattern; VITS insertion; control interface to probe/analyzer for auto setup of BM4400 color monitors.

Circle (369) on Reply Card

Video effects
By Pinnacle Systems

• **DVEator Creation kit:** software to develop digital video effects on an IBM PC or 3000 series system; DVEator effects animator for Prizm workstation maps live video onto 3-D-modeled shapes in real time; based on CrystalGraphics' Sculptor software.

Circle (370) on Reply Card

Graphic storage
By Quantel

• **Magneto-optical drive:** standard addition to Paintbox as well as JR and HD models; each removable disk includes a capacity of 650 images; M-O disk also permits transfer of images from one system to another, to Picturebox or Harriet editor.

Circle (371) on Reply Card

FM subcarrier application

By AXCESS

- **AXCESS 3000/RDS:** paging system based on RDS technology using FM broadcast subcarriers; permits global paging capabilities and information services; displayable on hand-carried unit with 4-line LCD display.

Circle (354) on Reply Card

Digital audio storage

By Barco-EMT GmbH

- **EMT-466 BEDAS MOD recorder:** storage to 3.2 hours of stereo on interchangeable magneto-optical disks; MUSICAM data format used for encoding; additional drives extend storage to 22.4 hours; three independent stereo outputs; analog and digital audio interfaces.

Circle (357) on Reply Card

Expanded monitor line

By Barco nv

- **Series 2000 monitors:** microprocessor control for reduced setup and adjustment, increased stability; CVM 2137 (14-inch) broadcast, CVM 2537 (14-inch) HR and CVM 2551 (20-inch) medium-resolution monitors; three composite, RGB/component, S-VHS video, audio input; RF section permits reception of all standards; CPM 2000 (21- and 28-inch) stackable monitors with flat square CRTs and input capabilities of CVM units.

Circle (355) on Reply Card

Edit control panel

By Editing Machines

- **EditPad:** array of dedicated function keys, number pad and shuttle knob condenses all necessary control functions into a panel easily accessible with one hand; avoids the need for a mouse and multiple menus; shuttle knob controls tape motion.

Circle (360) on Reply Card

Frequency measurement

By Optoelectronics

- **Model 2810:** hand-held frequency counter; covers range of 10Hz to 3GHz, displaying measured frequency on LCD panel (backlighted panel optional); gate times of 0.01s, 0.1s, 1s and 10s selected from front panel; sensitivity as low as 1mV to 200MHz, 10mV to 2.4GHz; antenna or probe inputs on BNC connectors.

Circle (366) on Reply Card

Multitrack disk recorder

By Otari

- **PD-464:** hard-disk recording system based on Mac interface; lockable to SMPTE time code; SCSI-compatible unit features crossfades, track slipping, auto punch-in/out; base system includes 120-minute record time; expansion to six hours and 8mm digital tape backup; Series III operating system with DSP option to control input/output levels, EQ, reverb, delay, mix operations.

Circle (367) on Reply Card

HDTV products

By BTS Broadcast Television Systems

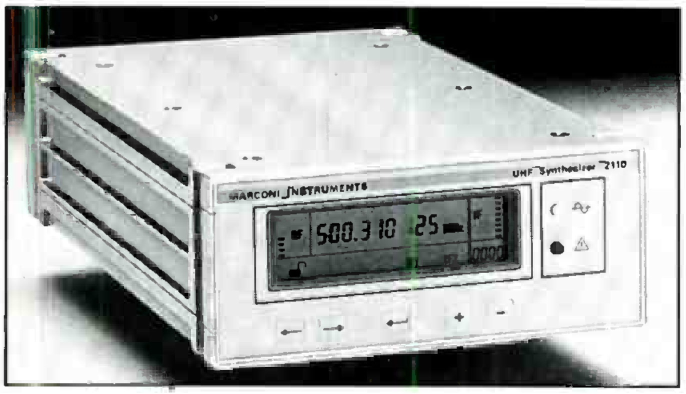
- **CPH 1000:** digital image enhancer; 2-D signal enhancement with positive/negative detail balance; adjustable coring; non-linear gain correction; detail signal from red, green or Y components.
- **RMH 1000 switcher:** HDTV production vision mixer with mixer input delegation, parallel access structured simultaneous switching of multiple programs from other control panels, automated key adjustment, Crystal Key feature; feeds from 30×20 switching matrix; extra function creates sequences with learn mode.

Circle (359) on Reply Card

RF signal sources

By Marconi Instruments

- **Model 2110:** TV transmitter synthesizer generates UHF carrier output and intermediate frequencies for audio and video signals in PAL, SECAM and other standards; direct UHF output between 430-900MHz replaces crystal-controlled equipment; precision offset capability with 25Hz resolution; model 2111 TV transponder synthesizer for use with up- and down-converters in transponder locks input and output to same frequency standard.



Circle (364) on Reply Card

Product information

By Emcor Products

- **Product Guide:** brochure introduces modular enclosure products and services; particular focus on ESQ, 10 series, Emcor 1, EMI-RFI-shielded cabinets and enclosure-cooling accessories.

Circle (361) on Reply Card

Product guide

By Frezzi Energy Systems

- **Frezzi 90's:** catalog illustrates updated series of battery, charger and battery conditioning products for video production, broadcast, cable and other portable power users.

Circle (362) on Reply Card

VTR control

By Lyon Lamb Video Animation Systems

- **MicroVAS animation controller:** enables single- or sequential-frame recording from computer graphics equipment to video recorders; field-accurate editing; compatible with $^{1}/_{2}$-, $^{3}/_{4}$- and 1-inch videotape formats and recordable laserdisc; RS-232, -422 VTR ports; VIFC (vertical interval frame code) time reference.

Circle (363) on Reply Card

Circle (87) on Reply Card

Circle (86) on Reply Card

Preview

October...

PROFITABLE TECHNICAL MANAGEMENT

• 11th Annual Salary Survey: My Share

Broadcast and post-production operations have never been so complex. The technical personnel required to operate these facilities are highly skilled and valuable. The salary survey looks at compensation programs by radio and television in three different categories.

• Engineers — Part of the Profit Team

Engineers should be part of the management team within a station. One key is to show the manager that you understand the need to be profitable. Another is to demonstrate creativity in helping the station make money. The article looks at ways engineers can become part of the station's profit team.

• Competing for Your Job

If you had to interview for your job today, would you qualify? That's an important issue many people forget as they become "comfortable" in their surroundings. The article prods readers to re-examine how important their skills really are to the station or production manager.

November...

EIGHTH ANNUAL STATION MAINTENANCE REPORT

• Troubleshooting Analog Systems

Servicing the high-quality analog equipment in a radio or TV station can be difficult. Sometimes, the performance of the equipment exceeds the measurement capability of the test equipment. The article looks at techniques that can help isolate and resolve analog problems without a truck full of test gear.

• Troubleshooting Digital Systems

Repairing modern digital equipment requires a special expertise. High-pressure-environment control rooms and production suites demand that the problem be diagnosed and solved in minutes, not hours. The article provides the technical aspect with a "cookbook" approach to solving digital-based problems.

• Caring for High-Power Tubes

Most broadcasters still use tubes in their transmitters. Today's tubes are reliable and efficient. Yet, to maintain long-life they need proper care and treatment. The article looks at important steps the engineer can take to ensure a long life from the transmitter tubes.

• Digital and Analog Fiber-Optic Transmission Systems

As video signals improve, the paths they travel must also improve. Component, RGB, M, D-1, D-2 and new signals must now be interconnected to a variety of equipment within the station. It's important that engineering managers understand where and how fiber fits within the TV station.

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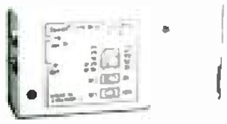

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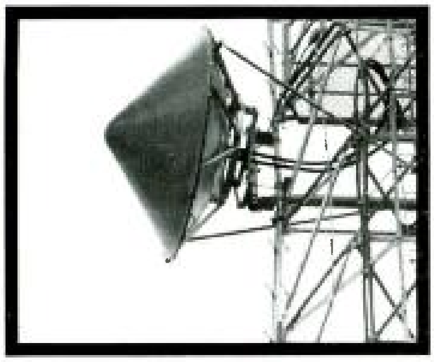

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