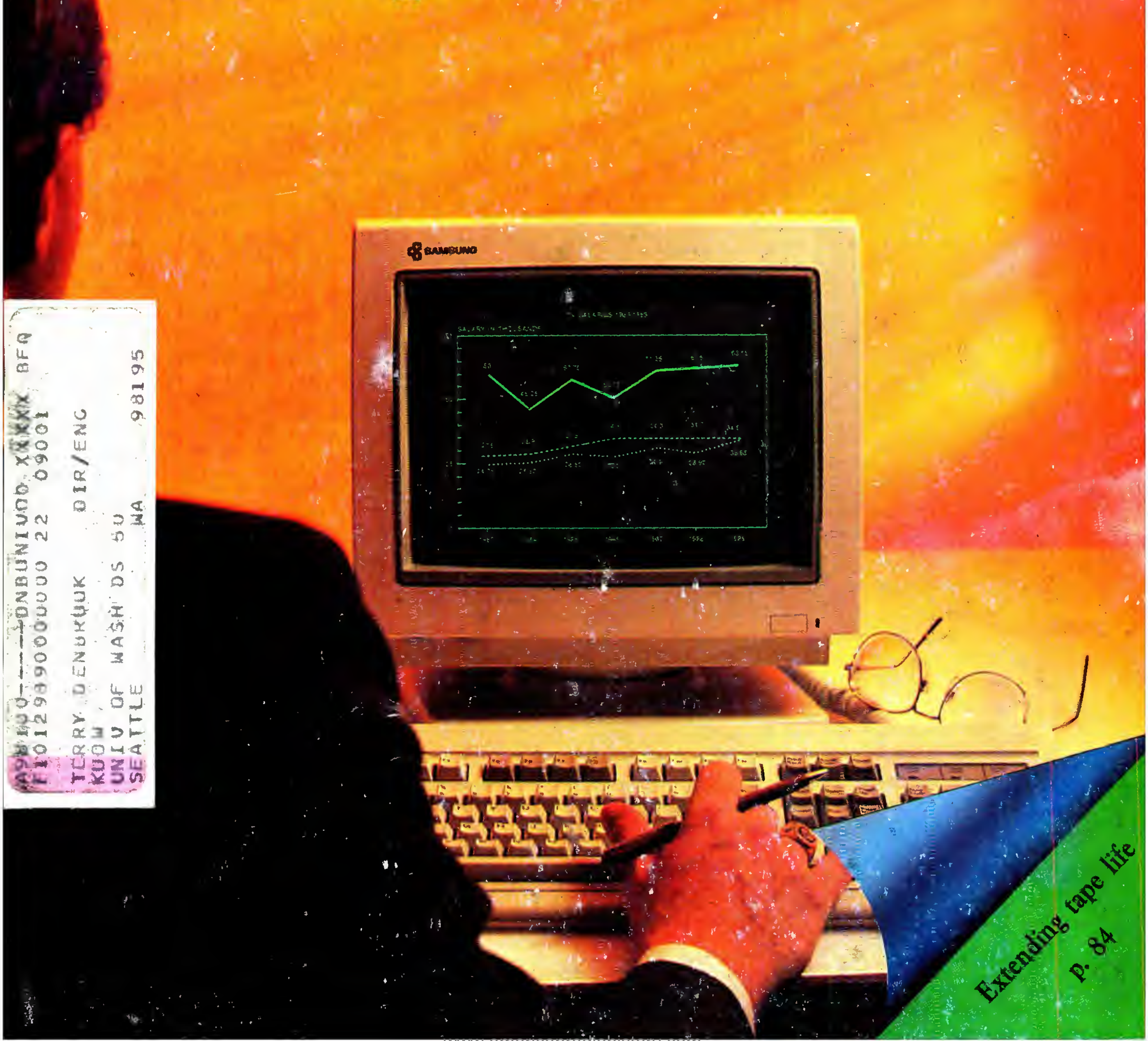
BROADCAST engineering®

AN INTERTEC PUBLICATION

October 1989/$4.50

Managing broadcast operations



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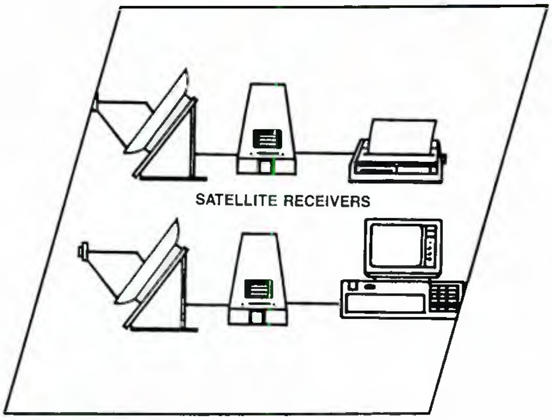

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ON THE COVER

How does your compensation package compare with those of your peers? This question and others are answered in the annual **BE** salary survey contained in this issue. (Cover design by Stephanie Swail, photography by Ed Reyes and Lisa Correu.)

DEPARTMENTS

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News

By Paula Janicke, staff editor

NAB names director, announces seminar

F. David Harris has been named director, special projects, of the National Association of Broadcasters' Science and Technology Department. He is the former head of the electrical engineering technology department at Purdue University, Calumet.

NAB also has announced that the University of Notre Dame, South Bend, IN, will be the site of the 25th Annual Management Development Seminars for Broadcast Engineers, a course offered by the association.

Slated for Feb. 4-9, 1990, the 5-day course is designed to develop and sharpen the managerial skills of broadcast engineers. It will be divided into three seminars. "Management I: Fundamentals of Leadership" will discuss proven concepts, methods and techniques of management. "Management II: Toward Leadership Effectiveness" will examine interaction with superiors, peers and subordinates. "Management III: Achieving Personal & Professional Excellence" will study methods and concepts for personal and professional self-assessment.

The seminar fee, which is $1,350 for NAB members and $1,650 for nonmembers, includes tuition, housing, instructional materials and some meals. For further information, contact NAB Science and Technology at 202-429-5346.

EIA joins in HDTV testing

The Electronic Industries Association (EIA) has become a member of the Advanced Television Test Center (ATTC), the organization established last year to test proposed high-definition TV transmission systems. The oldest and largest full-service national electronics manufacturing trade organization in the United States, EIA represents American manufacturers of electronic components, parts, systems and equipment.

ATTC is a coalition of TV broadcasting companies and industry associations formed to evaluate advanced TV systems being proposed as the new terrestrial transmission standard for HDTV in North America.

Hamilton to head ATTC computer engineering

Scott E. Hamilton has been named manager of computer systems engineering for the Advanced Television Test Center. He will be responsible for the development and management of computer and software elements required by the ATTC for its analysis of new TV transmission tech-

Continued on page 155

BROADCAST ENGINEERING

Editorial and advertising correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO); (913) 888-4664. Telex: 42-4156 Intertec OLPK. Circulation correspondence should be sent to the above address, under P.O. Box 12937. RAPIDFAX: (913) 541-6697.

BROADCAST ENGINEERING is edited for corporate management, engineers/technicians and other station management personnel at commercial and educational radio and TV stations, teleproduction studios, recording studios, CATV and CCTV facilities and government agencies. Qualified persons include consulting engineers and dealer/distributors of broadcast equipment.

BROADCAST ENGINEERING (ISSN 0007-1794) is published monthly (except in the fall, when two issues are published) and mailed free to qualified persons within the United States and Canada in occupations described here by Intertec Publishing Corporation, 9221 Quivira Road, Overland Park, KS 66215. Second-class postage paid at Shawnee Mission, KS, and additional mailing offices. POSTMASTER: Send address changes to **Broadcast Engineering**, P.O. Box 12960, Overland Park, KS 66212.

SUBSCRIPTIONS: Broadcast Engineering is mailed free to qualified persons in occupations described above. Others may subscribe at the following rates: United States, one year, $50; all other countries (surface mail), one year $60. Rates include postage. Foreign air mail and Canadian first class options are available at the annual subscription rate of $115. Single copy price $4.50, except for the annual Buyers' Guide/Spec Book, which is $20. Back issues, when available, $5; Buyers' Guide/Spec Book back issues $23. Adjustments necessitated by subscription termination at single copy rate. Allow six to eight weeks delivery for change of address or new subscription.

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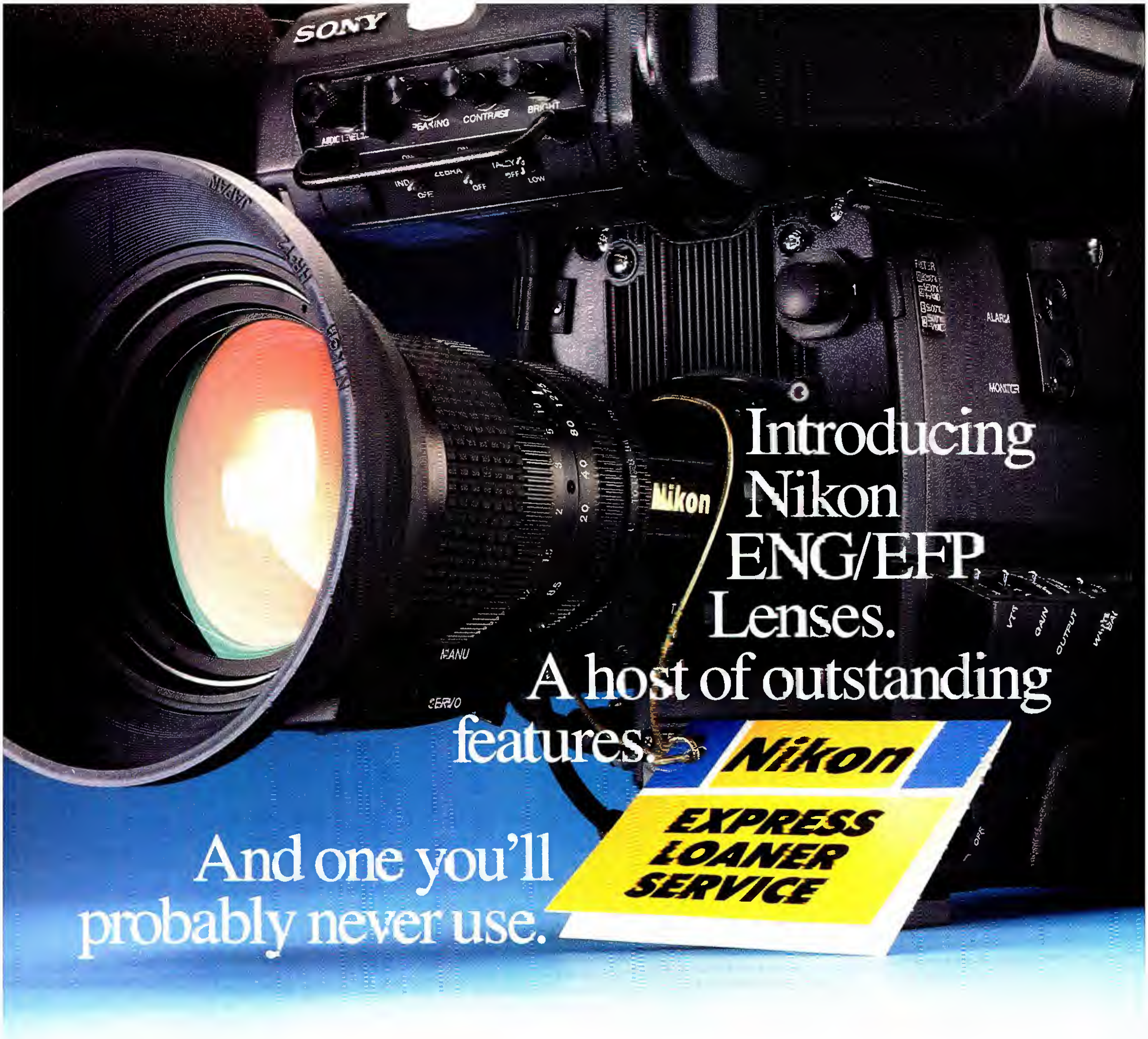

Selecting an ENG/EFP lens for your ⅔″ CCD camera is a creative decision. It should be lightweight, responsive and zoom smooth as silk at any speed. Its design should utilize Extra-low Dispersion Glass to minimize chromatic aberration. It should include an anti-reflection coating for improved spectrum transmission ratio. And it should have an advanced design that improves corner resolution and produces a high, flat MTF curve. In short, it should be a Nikon.

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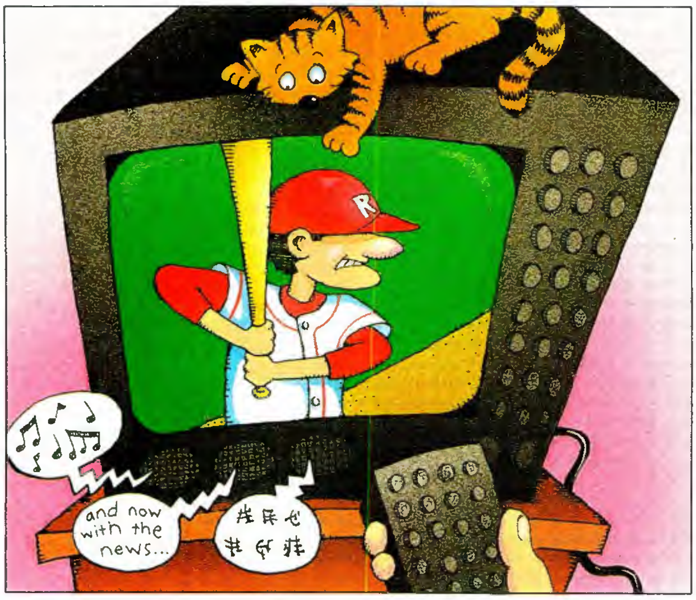
Circle (4) on Reply Card

Taking audio beyond "basic black"

Henry Ford might have had the right idea when he said that his customers "could have their automobiles in any color they wanted — as long as it was black." There is wisdom in doing one thing, doing it extremely well, and not cluttering the mind or workplace with distractions.

But, as we all know, Henry lost the argument. Cars come in a wide spectrum of colors, and there are shapes, styles and features to match every taste. Although this diversity may be frustrating to the manufacturer, mechanic and body shop, one fact remains: variety sells a lot of cars. You can find one that will fulfill whatever needs compel you to buy one.



TV audio has traveled a similar path to diversity, and now it has reached a crossroads. Someone once decided that instead of "basic black," we needed several options. Today we have mono, stereo and a secondary audio program (SAP) besides. The market is now flooded with both conventional and multichannel TV sound receivers and VCRs.

This is where Henry's wisdom really shows up. It takes just about the same amount of smarts to drive an Italian sports car as it does to navigate the family station wagon. But, as any broadcaster who has tried to use the SAP can testify, viewers have a tough time getting used to multichannel TV sound. The audio selector switch confuses many listeners in the same way that a stick shift muddles the mind of a driver who's used to an automatic.

Many stations have thrown the stereo switch. In many cases, this means that they have fired up a pseudostereo encoder and turned on the little red light on the TVs in their viewers' homes. "Sure sounds good," the viewers say. "Honey, look at the 'stereo' light!"

For a reasonable hardware investment, these stations have tracked the state-of-the-art and pleased their viewers. But now, some stations are going on to use the SAP channel. Some simulcast their radio properties. Some use the SAP to distribute promotional teases for that evening's newscast to the local radio stations. Some air the National Weather Service audio feed or sell audio spots against a repeating local weather forecast prepared by the station's meteorologist.

Throwing the stereo switch is easy; throwing the SAP switch is traumatic. Although most TV set owners feel good about the little red stereo light, it seems few of them know how to read the set's instruction manual, especially the part about where to set the audio select switch. When the picture and the sound don't match, these set owners either jam the switchboard with calls for help (which is good), or they just figure the station has an audio problem, and they change channels (which is bad). Some viewers have given up watching SAP active channels, convinced the stations have chronic, unresolved audio difficulties.

Perhaps we broadcasters have brought this situation on ourselves. If our station salespeople can trumpet our ability to reach the people, why can't we use our resources to promote the SAP? If they were prepared for it, viewers could, undoubtedly, better utilize the SAP signal. We might even consider (gasp) a newspaper campaign to advise them of our new, expanded services.

In the viewer's defense, on all but two brands of TV sets, the audio selector can toggle among stereo, mono, SAP and SAP+MONO, the latter being a condition of questionable use. At best, it defeats the station's attempts at stereo; at worst, it confuses viewers. Standardization among manufacturers could eliminate this problem.

This situation would be merely frustrating if it weren't happening in the looming shadow of something even worse. There are voices in our industry encouraging us to quickly pick an HDTV standard. The options on the table are politically laden. Even the experts can't figure out what's best. If an extra channel of audio throws viewers for a loop, what will happen in the future, when the option switches may affect picture size as well? Before we race to provide any more high-octane, futuristic services, let's first learn how to promote what we've got.

Rick Lehtinen

Rick Lehtinen,
TV technical editor

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Circle (5) on Reply Card

Separation tables amended

By Harry C. Martin

In connection with authorizing an increase to 6kW maximum effective radiated power (ERP) for FM Class A, the commission amended its minimum distance separation requirements for the class. The new separation table — FCC rule Section 73.207(b), Table A — is shown in Table 1. The remainder of Table A, which sets minimum distance separations between FM classes B1, B, C3, C2, C1 and C, is unchanged.

Table B in Section 73.207(b), which sets the mileage separations between U.S. and Canadian FM allotments, remains unchanged also. However, proposals for Class A assignments operating with more than 3kW ERP and 100 meters antenna height above average terrain (or equivalent lower ERP and higher antenna HAAT based on a class contour distance of 24km) will be considered to be Class B1.

The distance separations specified in Table C of Section 73.207(b), which apply to U.S. FM assignments vis-a-vis Mexico, are unchanged. However, under the Mexico-United States FM treaty, Class A assignments operating with more than 3kW ERP and 100 meters antenna HAAT (or equivalent lower ERP and higher antenna HAAT based on a class contour distance of 24km) will be considered to be Class B.

Stations at locations authorized by grant of applications filed before Oct. 2, 1989 that became short-spaced as a result of the adoption of the new separation table for Class A may be modified or relocated in accordance with the following "grandfather" provisions:

- Each application for authority to operate a Class A station with no more than 3kW ERP and 100 meters antenna HAAT (or equivalent lower ERP and higher antenna HAAT based on a class contour distance of 24km) must specify a transmitter site that meets the distance separation requirements shown in Table 2. Each application for authority to operate a Class A station with more than 3kW ERP (up to a maximum of 5,800W), but with an antenna HAAT lower than 100 meters, such that the distance to the predicted 0.05mV/m (34dBu) F (50,10) field-strength contour does not exceed 98km, also must specify a transmitter site that meets the minimum distance separation requirements shown in Table 2.
- Each application to operate a Class A station with an ERP and HAAT such that the reference distance would exceed 24km must contain an exhibit demonstrating the consent of the licensee of each co-channel, first-, second- or third-adjacent channel station, for which the separation requirements are not met. Applications that specify a transmitter site that is short-spaced to an FM station other than another Class A station seeking a mutual increase in facilities may be granted only if no alternate fully spaced site or less short-spaced site is available. Licensees of Class A stations seeking mutual increases in facilities need not show that a fully spaced site or less short-spaced site is available.

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

Editor's note: This is intended to be a summary of the most important new rules rather than a complete rendition of the new Class A FM separation standards.

RELATION	CO-CHANNEL		200kHz		400/600kHz		10.6/10.3MHz	
A to A	115	(71)	72	(45)	31	(19)	10	(6)
A to B1	143	(89)	96	(60)	48	(30)	12	(7)
A to B	178	(111)	113	(70)	69	(43)	15	(9)
A to C3	143	(88)	89	(55)	42	(26)	12	(7)
A to C2	166	(103)	106	(66)	55	(34)	15	(9)
A to C1	200	(124)	133	(83)	75	(47)	22	(14)
A to C	226	(140)	165	(103)	95	(59)	29	(18)

Table 1. The new separation table for FCC rule Section 73.207(b). The distance is shown in kilometers, with the miles shown in parentheses.

RELATION	CO-CHANNEL		200kHz		400/600kHz		10.6/10.3MHz	
A to A	105	(65)	64	(40)	27	(17)	8	(5)
A to B1	131	(86)	88	(55)	48	(30)	11	(6)
A to B	163	(101)	105	(65)	69	(43)	14	(9)
A to C3	138	(86)	84	(52)	42	(26)	11	(6)
A to C2	163	(101)	105	(65)	55	(34)	14	(9)
A to C1	196	(122)	129	(80)	74	(46)	21	(13)
A to C	222	(138)	161	(100)	94	(58)	28	(17)

Table 2. "Grandfathered" minimum distance separation requirements. The distance is shown in kilometers, with the miles shown in parentheses.

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Circle (6) on Reply Card

Organize maintenance with software

By Rick Lehtinen, TV technical editor

Now, more than ever, it is important to be cost-effective in our maintenance activities. The bad news is that this will require some self-discipline. The good news is that we are not alone. Equipment fixers from all industries have had to tighten their belts and learn efficiency. Some excellent maintenance software is available, and although it may have been developed for general industry, it is certainly adaptable to broadcasting.

Maintenance software builds a framework for an organized maintenance program. Through the software, complex information about equipment, including parts, warranties, vendors and labor, can be found with only a few keystrokes. You can pull up the history of a machine to see whether preventive maintenance is getting done. You can control your spare parts inventory, keeping costs down. Through search and sort functions, you can create reports to help you determine how much it really costs to maintain a piece of equipment. You can perform many other insightful, cost-saving analyses that would take too much time to complete if you tried to do them manually.

Setting up a PM program

Many stations favor preventive maintenance, but few practice it. Equipment that fails in the field is double trouble. First, it takes time and money to fix. Second, you can't use the equipment during the time it is down for repairs.

Acknowledgment: The author wishes to thank Mark Smith of Datastream Systems for help in the preparation of this article.

To set up a PM program, you need a scheduling system. Today's maintenance software can print out a work order according to meter hours (odometers, in the case of vehicles), date, or time elapsed since the last service. The last factor is especially important. If the equipment should be serviced biweekly, but something delays your getting to it, you need to move back the schedule. Also, some tasks should be performed "every 500 hours or six months." Without a computer, this kind of bookkeeping can be tedious.

Work orders

The primary document used to authorize maintenance and repair work is the work order. Work orders are generated whenever equipment breaks, when an installation project needs doing or when the scheduling system indicates it's time to look at a piece of equipment. Good maintenance management systems can create work orders complete with repair instructions, lists of special tools needed, causes for equipment failures, estimated cost and time for repairs, equipment history, equipment availability and scheduling data. Armed with this type of information, the engineer should be more productive.

Parts

Stations spend a lot of money each year on spare parts. Ideally, inventory should be kept just large enough so that you have sufficient supplies of what you need on hand, but never an excess. Modern maintenance software often can alert you when inventory levels dip below certain preset levels. It also can keep vendor data handy, develop shopping lists automatically and even generate purchase orders.

When parts are received, the software can keep track of which purchase order they were charged against. (See Figure 1.) Some software includes provisions for the checkout and return of vehicles or specialized tools. If these can't be found, it is easy to learn who had responsibility for them previously.

Personnel

A comprehensive maintenance package might also account for personnel time. Such software can track vacation and sick leave hours used, time used to complete jobs, or create a rundown of what human resources you will have available at some future point. You can, for instance, look ahead to find a suitable week to undertake a major installation project. Based on its information about vacation and maintenance schedules and special events for which you must schedule personnel, the computer can guide you to select a week in which you can complete your project with adequate staff on hand.

History

Another benefit to computerizing your operation is that it enables you to more easily draw on experience. Notes from experienced employees that specify just what items should be checked at each PM interval can be attached to the work order. Also, eventually you will have a history of how long it takes to perform certain tasks. With this document, you can further refine your projections.

KNNN TV ENGINEERING
Order Costs by Purchase Order Number
Run date: 9 Sept 89

P.O. #	Item Description	P/N	Date Rx'd	Quan Rx'd	Cost/ea.	Total
E-5467-T	Spring, Relay	43-1237	8/22	3.0	1.27	3.81
E-5467-T	Spring, Dashpot	44-5691	8/23	2.0	3.10	6.20
E-5467-T	Screw, 6-32 HEX	19-13267	8/23	12.0	0.17	2.04
E-5468-T	Res. 10.0 @ 1/4W	135AX4010	8/23	10.0	0.04	0.40
E-5468-T	IC SN74LS32	986-74LS32	8/23	5.0	0.33	1.60

Figure 1. *Modern maintenance software packages cannot only generate work orders and track employee hours, but also can keep up with inventory levels and parts orders.*

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You're no amateur at this game, so why play around with amateur CD players in the studio? You've tried consumer models in the past, just to see if they'll work long enough to make sense. We can understand that. But in the long run, they *don't* make sense. And you know it. Even modified or beefed up versions have given you headaches. . . wrong levels, hifi connectors, too many buttons or the wrong ones. Not to mention skips, mutes and breakdowns. Why take chances playing around with an amateur deck in a pro application? Leave that home player at home where it belongs. Check out the Studer A727 and A730—pro players for radio pros.

A727 ▶ Thousands of A727's prove their reliability in radio stations all over the world—*everyday*. The A727 provides full 16-bit resolution with 4x's oversampling—plus powerful error correction circuits to protect against on-air problems from damaged or dirty discs.

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FEATURE	A727	A730	"Brand X" Player	FEATURE	A727	A730	"Brand X" Player
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Parallel Remote w/Tallies	▼	▼		Varispeed Built-in		▼	
Start & End Review	▼	▼		End of Modulation Sense		▼	
End of Track Alarm	▼	▼		Monitor Speaker		▼	
RS422 Serial Control	▼	▼		Separate PGM & Monitor Outputs		▼	
System Clock in/out	▼	▼		Remote Monitor Speaker Mute		▼	
Digital Output	▼	▼		Audio Channel Reset		▼	
Die-cast CD Drive	▼	▼		Rack Mounts Standard	▼		
Cue Memories		3		Flush Mounting		▼	

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Circle (7) on Reply Card

Part 1

Pre-winter maintenance checklist

By John Battison, P.E.

Before too long, many of us will be experiencing freezing ground and heavy rain and winds. The engineer whose transmitter adjoins the studios will be in a far better situation than the one whose transmitter is on a mountaintop or remote from the studios. Whether your station is FM, AM DA or non-DA, proper maintenance will help ensure winter survival.

Begin the inspection

Several checks should be made before cold weather sets in. Check lines for leaks. Lines pressurized with either air or nitrogen can be checked with soap or another gas detector. Run a time check on nitrogen bottles. This will help ensure that you don't have to drag new bottles to the transmitter in the dead of winter. If you use dry air, be sure your desiccant is drying out properly after each use. Verify that the compressor is well-serviced and ready for a long winter.

Sometimes, long vertical runs of transmission line are not pressurized, so be sure all joints are tight. If the time to replace tower light lamps will fall during winter, consider having them changed now. At the same time, have the climber check all the transmission lines. This inspection should include the transmitter, STL, 2-way and RPU lines. Be sure all joints are well-sealed and waterproof. The variable temperatures of summer tend to loosen these fittings.

If you suspect even a small gas or air leak, have the climber inspect each joint on the way up and down. Summer's heat can expand a joint so it barely leaks at that time, but contraction with cold may result in a sizable leak later.

Antenna-mounting brackets have been known to work loose during summer storms. The outer covering of jacketed line can rub away if the mounting clamps have deteriorated. Be sure that your STL lines are secure and that antenna mounts are not rusted or loose.

If, for any reason, you have "hot" equipment up the tower, be sure it is in tiptop condition. If necessary, replace any questionable boards, and double-check ac line feeds.

It goes without saying that the remote building must be spotless, all filters clean and storm vents in place. Perform a full-scale maintenance check of the transmitter. Double-check any dubious or critical units, and be sure enough spares are on hand.

Spares should include food, water, blankets and additional heating equipment. These items will be critical if you become isolated at the site during periods of bad weather. Hams probably already have a ham rig at the plant. In any case, it is a good idea to have a secondary communication unit available in case of emergency.

All fuel tanks for standby power should be filled, and drive units should be checked for oil and coolant. It's a good idea to check for water in diesel units and to be sure that the electric heater is still working. Antifreeze should be replaced as necessary, and batteries given a discharge and starting check to ensure an immediate response when the power fails.

Auto power changeover switches should not be overlooked. Unless you suffer frequent power outages, they probably don't get much use, and most engineers run their standby units on a regular check basis. However, the starter batteries sometimes run short of electrolyte if left on a trickle charger that is a bit hot. Check the battery's condition and specific gravity.

Tower inspection

Now is a good time to get a tower engineer to check the tower for plumbness and any signs of torque damage. Guy wires should be greased if needed and turnbuckles checked for tightness and locked. This will help prevent animals in need of a good scratch from loosening them while having a back rub!

Now is the time to be sure your paint will stand the winter weather, and that lights will go on when the northern sky darkens. Photo-cell covers and relay contacts should be cleaned.

Winter lightning can be worse than summer lightning in some locations. An AM installation already should have an excellent ground system, but FM towers are not always grounded as well as they should be. In sandy, dry soil, especially in regions where winter or summer lightning is prevalent, it is a good idea to add a real ground system of some kind. This may take the form of grounding rods driven deep and soil seeding with suitable conducting chemicals.

AM transmitter sites

A station engineer cannot accomplish much if the FM antenna is perched several hundred feet in the air. At an AM site, however, several things can be done.

DA and non-DA installations require the usual transmission-line inspection leading up to the ATUs. With above-ground lines, be sure all supports are firm and that the lines are supported securely. Grounding straps must be attached properly and all lines bonded to it.

End seals should be checked, and rigid lines (not too many exist these days) examined for bends and strains due to heat expansion. Look in the ATUs. Summer's wasp and vermin nests must be cleared away. Check all coil clips, and be sure connections are tight and clean. If you remove any clips for cleaning, be sure you mark their location *before* removal.

Next month, we'll continue our discussion on pre-winter maintenance. Don't wait for cold weather to strike; perform this important maintenance work now.

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

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Circle (8) on Reply Card

Winter's coming; prepare now!

By Elmer Smalling III

It's that time of year when broadcasters should think about preparing their satellite earth stations for winter. Many stations installed their satellite equipment 10 or more years ago, and, like anything else that must withstand the continual barrage of the elements, antennas and transmission systems require periodic maintenance or replacement.

The largest single part of the earth station system, the dish reflector, will degrade in the weather to the point at which the dish sections or petals begin to separate or warp. Moderate surface warping or petal separation can reduce antenna gain by at least 6dB. If the antenna feedhorn is tripod-mounted, the tripod may become offset from boresite focus by the dish's warping action. The feedhorn, waveguide and support mechanism also may warp and corrode, causing signal degradation because of focus offset and depolarization of the feedhorn.

Metal dishes may corrode at connection points and support struts. Dishes that are covered by plastic or fiberglass may suffer the same corrosion, but it will remain hidden under the coating, much like rust on the underbody of an automobile. A dish with a corroded surface can degrade the gain of the antenna system from 3dB to 6dB.

Keep your eyes open

A simple physical inspection will reveal a lot about your dish. You can't chip and repaint the surface of a dish antenna. The reflector surface must be smooth and electrically conductive. When the antenna system has severely degraded, often it is less expensive to purchase a new system than to attempt repair of the old one.

If you are in the market for a new antenna system, note that they have dropped in price. The prices for antenna systems have shrunk by half over the past 10 years, thanks to the home TVRO users who caused many manufacturers to enter the market.

If there is enough room at the antenna site, a new dish can be mounted and tested while the old one is still in service. If there is not room for two dishes, you might plan your design around the existing moorings so that changeover will take as little time as possible.

Autumn breeze

If the antenna and feed system have held up well, check the system's alignment next. Shifting ground conditions and strong wind can offset the dish in azimuth or altitude enough to cause signal losses of up to 6dB. Tuning a dish involves mechanically adjusting its position while observing the AGC or the "extension meter" signal on a meter. Find an active transponder, then alternately peak each axis of motion. Next, rotate the feedhorn to adjust polarity. Because the steps are somewhat interactive, repeat the procedure several times.

The next area to check is the transmission system. If you are using coaxial cable, check all connections and any passive or active devices or junction boxes that are subject to weather damage. A loose or oxidized connector can reduce your signal or cause intermittent noise. If you have any doubt about a connector, replace it. Check the flanges, gaskets and supports if you are using waveguide transmission line. Because it has less mechanical freedom than flexible coax line, waveguide is susceptible to torque and stress at the flanges. If you have a nitrogen or dry air system, check for system leaks.

Ice follies

If you have had problems with icing over the years, now might be the time to install a dish de-icing or heating system. A number of types are available, but the most popular is the hot-air-and-boot system. The rear of the antenna reflector is "booted" with a weatherproof piece of material and connected to a heater through a piece of flexible tubing that resembles clothes dryer vent hose. An electrical heater mounted at the dish will require at least 2kW of power at the dish site. If you're going to install a heater, make sure to do it right the first time; making repairs on a heater system while standing in three feet of snow is less than ideal!

Final check

Measure the signal strength, and compare it to that received over the years. If the footprint signal has dropped, you can take a few remedial measures. First, increase the gain of the system by installing a lower-noise LNA. Second, consider mounting the receiver near the dish site and feeding video and audio into the station. Of course, this will require an equipment housing at the dish site, as well as a way to remotely control the receiver, but if the transmission line you are replacing exceeds a few hundred feet, you might pick up from 2dB to 6dB. For extra-long runs, consider routing the signals back to the station on fiber optics. Last, increase the size of the dish. This will make a marked improvement in the signal strength and picture quality.

You also might examine the satellite receivers you have had for all these years. Today's consumer models costing a few hundred dollars are often far superior to the industrial-strength units installed in the '70s.

Police the area around the dish to be sure it is clear of debris and other objects. If you have to service the dish in winter, the mud, snow and ice will make the job hazardous and uncomfortable enough without the added danger of ice-covered obstacles.

Smalling, **BE**'s consultant on cable/satellite systems, is president of Jenel Systems and Design, Dallas.

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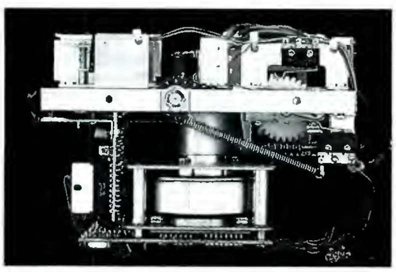

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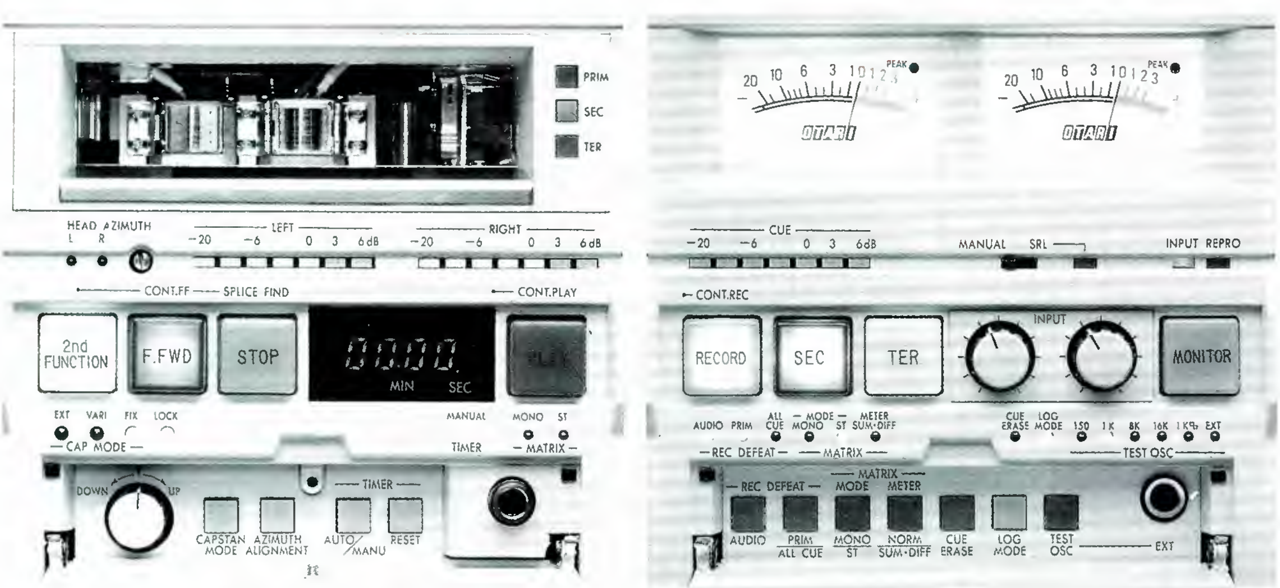

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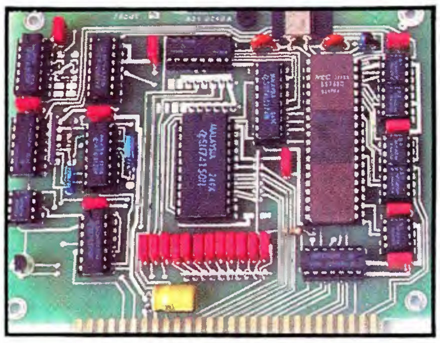
Circle (9) on Reply Card

Thermistors measure microwave power



By Gerry Kaufhold II

Determining the strength of a microwave signal is an important application for thermistors. Usually, this is done with a pair of closely matched thermistors. One thermistor, housed in a reflective container to protect it from radiation, is used as a reference. The second thermistor is exposed to microwave energy, causing it to heat. The difference between the reference and irradiated thermistors provides a way to determine the energy absorbed. The thermistors used for measuring microwave radiation are costly, because they must be small and provide stable electrical performance.

Weird science

The science of measuring microwave power is somewhat arcane. Microwaves require "special handling" among forms of radiation, because they often behave more like light than electrical fields.

The first step for designers is to determine whether the measurement will be performed inside a waveguide (measuring actual microwave energy contained within a system) or outside the antenna (measuring actual microwave power output).

Kaufhold is a market development engineer for SGS-Thomson Microelectronics, Phoenix.

Next, they define the environment in which the tests will be performed. The ambient temperature must be standardized (usually 25°C is chosen), and the operating temperatures then must be held within ±10°. The frequency range of interest must be defined, because the bead thermistor must be close in size to the wavelength of the frequency being measured. The power range also must be specified, because the bead thermistor can absorb only a limited amount of energy. For high-power measurements, special taps must be fitted that deliver a known portion of the microwave signal to the measurement device.

Once the environmental considerations are determined, a thermistor must be chosen to fit the job. This requires more attention to detail than might be expected. The first parameter to consider is the thermistor's physical size. Glass bead thermistors are available in diameters from 20 thousandths of an inch (0.020″) down to five thousandths (0.005″).

Because thermistors are semiconductors, the lead wires must be spot-welded into place. For very small thermistors, lead-wire-bonding must be done under a microscope, which results in a lower usable-parts yield and a much higher cost. Standard-size bead thermistors have a base cost near $5 each; very small bead thermistors cost more than $50.

Also, the two thermistors used for microwave measurement must be as closely matched as possible. Not only must their resistances be the same at various temperatures, but the slopes of their R-vs.-T curves must be identical to permit accurate interpolation between match-points. The manufacturer generally provides a matching service. Thermistors are rough-sorted according to their resistance at various temperatures, then fine-sorted according to their R-vs.-T slope characteristics. This explains why the cost of microwave power measurement goes up as frequency increases.

Crossing the bridge

Because temperature rise is the measurement needed, a high-impedance bridge circuit compares the reference thermistor with the sampling one. The difference can be manipulated to derive the amount of microwave power. The bridge circuit is quite sensitive and complicated. Microwave energy will heat the metal lead wires that connect the thermistors to the measurement circuitry. The wires will act as antennas, directing microwave RF into the front end of the bridge circuit. Therefore, the inputs of the circuitry must be fitted with microwave chokes and a way to dissipate any microwave energy received, and the thermistor must be protected from self-heating caused by microwaves on the lead wires.

Because analog circuitry can vary because of temperature, moisture and mechanical stress, microwave power often is measured with digital signal processor techniques, with the stored characterizations of the matched thermistors used to "iron out" deviations from the calibrated values.

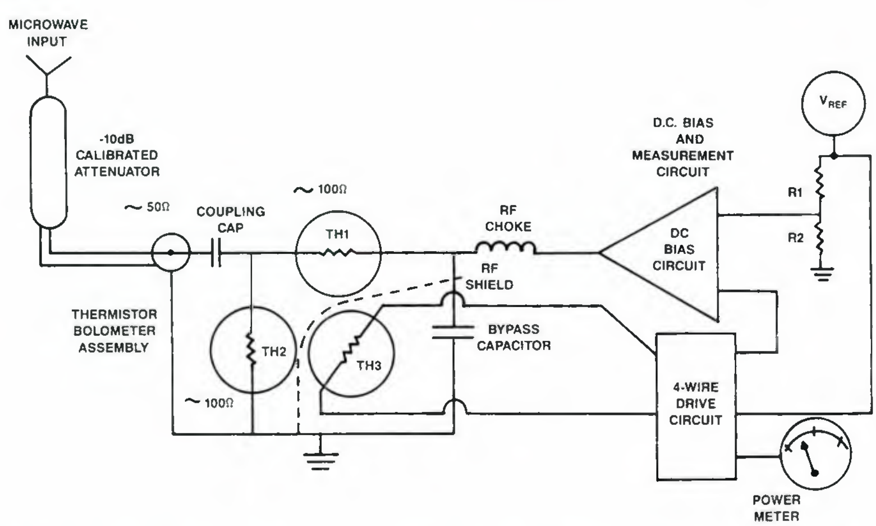


Figure 1. Direct coupled thermistor bolometer. D.C. bias preheats thermistors 1 and 2 so that they present an input impedance of 50Ω. Thermistor 3 senses a rise in temperature when microwave energy is applied.

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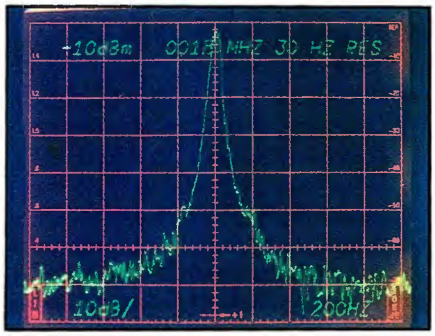

CD troubleshooting

By Brad Dick,
radio technical editor

Last month, we examined the physics of scratches and how they affect CD playback. Before leaving the subject of CD scratches, let's consider why they can be so troublesome.

In addition to causing tracking problems, scratches also can affect the size of the laser beam. The entire disc is a part of an optical system designed to focus the beam precisely down to an approximate $1.2\mu m$ spot. If the disc thickness changes, either because of a manufacturing defect or large scratch, the beam size is altered. If the beam illuminates more than one track, the reflected information may confuse the servo mechanism. If the reference is lost, the pickup assembly may skip or jump as it looks for the proper location or good data.

Even the direction of the scratch has a great deal to do with whether the damage is noticeable. A scratch running perpendicular (radial) to the tracks causes less of an audio recovery problem than one running parallel to the tracks. Let's see why.

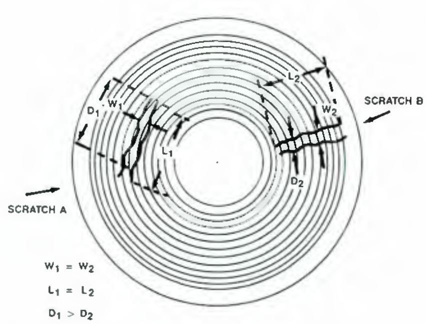

Figure 1. The direction of a scratch can have a great effect on its audibility. Tangential scratches are much more detrimental to recovering audio than radial scratches.

Figure 1 shows a CD with two scratches, one parallel to the tracks (A) and one perpendicular to the tracks (B). Note that the physical dimension of the two scratches, width (w1 and w2) and length (l1 and l2), are the same. The length of the actual CD track affected by each scratch is symbolized by distances d1 (scratch A) and d2 (scratch B).

The scratches look the same. However, scratch A affects more continuous linear track space than scratch B (d1 > d2), and therein lies the problem. The longer the damage along the CD track, the more difficult it becomes to recover the audio. In this example, audio recovery might be impossible for scratch A, while no effect would be heard from scratch B.

The designers of the CD recording process recognized the likelihood of surface damage and contamination, and they took several steps to minimize its effects. One of these error-correction techniques is called *interleaving*.

Interleaving

Each time a surface defect (such as dirt, a scratch or a spot) occurs, several adjacent bytes of data are affected on the CD. If the databytes belonged to the same frame, even minute scratches might prevent the recovery of audio.

The scratches look the same.

tially. If a scratch, black spot or other damage occurs, a large number of contiguous bytes are lost. In this example, the missing seven bytes of data make the recovery of the words (data) — "music" and "sounds" — impossible.

The interleaving process rearranges the sequence of the data bytes along the CD track. Instead of recording the databytes consecutively (in a time-sequenced manner), the data is rearranged and recorded out of sequence.

The result is that the time-related bytes of data are not located adjacently to one another. During playback the data is reassembled in the correct order for proper reproduction. The playback process requires that the data be temporarily stored in RAM and then retrieved in the proper order. The process is quite complex as you will see in another column.

The advantage interleave offers to the user is greatly increased reliability. Thanks to interleaving (and an error-correction scheme), even if large amounts of data are lost, the missing elements can either be reconstructed exactly, approximated or the output can be muted in a worst-case condition.

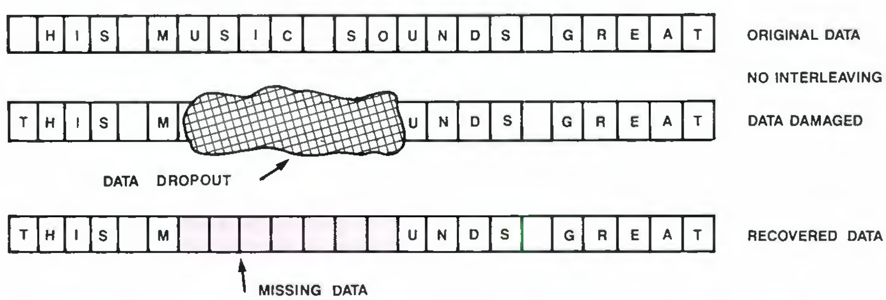

Figure 2. Without interleaving, any damage affects contiguous bytes of data. In this case, recovery of the missing information is impossible.

The interleaving is used to avoid multipositional errors in a frame during playback. The CD error-correction scheme is called *Crossinterleaved Reed-Solomon Code* (CIRC). However, at this point, we're only discussing the actual locations of the encoded data on the CD. We'll cover the complex area of error correction later.

Figure 2 shows one way separate bytes of audio could be recorded on a CD. To better understand the process, imagine the small squares as bytes of data from the CD track stretched out in a straight line. In this example, each databyte is recorded time-sequentially and contiguously along the CD track. If the audio frame required 32 bytes, all 32 would be recorded sequentially.

Next month, we'll continue our look at CD damage and the ways manufacturers prevent us from knowing it's there.

Acknowledgment: Appreciation is expressed to Laura Tyson, sales engineer, Denon America; Martin Ledford, quality control manager, Denon Digital Industries; and Dave C. Bowman, director of professional products, Studer Revox, for their help with this column.

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Part 7

Management for engineers

On being a leader

By Brad Dick,
radio technical editor

Be honest. Isn't there someone at your station you'd really like to dump? You know, someone who does things that make you angry? Is there a program director, general manager or disc jockey who really bugs you? In case you can't think of anyone, perhaps these examples will ring a bell:

- The program director decides, without even talking to you, what remotes will be broadcast.
- Your general manager often "forgets" to tell you all you need to know about his latest project.
- The Saturday evening DJ continues to damage equipment, yet the boss won't fire him.
- Jane is absent more than anyone else, and your staff often has to cover for her.

Whose problem is it?

Where is the problem in these examples? Is the problem the other person or is it how the other person's behavior affects you? Let's look more closely at this.

In the first example, the program director is scheduling your time and resources. The second example shows how information, or lack of it, can be used as a powerful tool. The third and fourth examples also illustrate how another's action can affect you. Any of these situations could make you feel angry, frustrated and powerless.

What's important to recognize here is that the other people are feeling none of those emotions. Notice that the program director is entirely satisfied with the situation. She is getting what she wants — your support for her remotes. The general manager doesn't see a problem; after all, he gave you what he thought was enough information. The other examples are similar. In each case, the other person doesn't have a problem — you do.

Assertiveness skills

Last month we discussed an effective approach to helping others solve their problems: active listening. When another person owns the problem, active listening coupled with the six steps of problem resolution often is effective. However, when you own the problem, the counseling approach typically will not work. Instead, you must be more assertive and try to influence the other person's behavior.

Use assertive language to convey your concerns to the other person. Keep in mind that being assertive does not mean acting like a steamroller. Using heavy-handed language does not promote effective communication, let alone problem-solving.

"You" language

One difficulty with assertive language is that it's easy to fall into the trap of using *you* terms. Do these statements sound familiar?

- "You stop it."
- "You shouldn't be doing it that way."
- "If you don't. . ."
- "Why do you always do that?"
- "Here is what you should do."

These can be called *you* statements. It is tempting to use such statements because they seem so powerful. Unfortunately, such statements create a communication gap between the parties. Remember how you felt the last time someone used them on you? Probably not very good.

Messages containing a strong *you* component act as roadblocks to effective communication. They can make the other person feel guilty or hurt. *You* messages often are perceived as punitive and may damage the other person's self-esteem. If this happens, reactive or even retaliatory behavior may result. In any case, *you* statements often generate resistance, not openness, to change.

If the *other* person owns the problem:
- **You're a listener.**
- **You're a counselor.**
- **You want to help them.**
- **You're a sounding board.**
- **You accept their solution and don't need to be satisfied.**
- **You're passive.**

- **If *you* own the problem:**
- **You're a sender.**
- **You're an influencer.**
- **You want to help yourself.**
- **You want to sound off.**
- **You must be satisfied with the solution.**
- **You're assertive.**

Table 1. *The style of communication needed for effective problem-solving depends on who owns the problem.*

Modify your approach

Here are a couple of ideas that may improve your communication effectiveness. First, recognize that people seldom engage in certain behavior simply because they want to make you feel bad. People act in particular ways *because it meets their needs*. Period.

The second point to remember is that people seldom are aware that their behavior is upsetting to others. Unless you tell them that their behavior concerns you, they'll probably never know. If you decide to confront them, what is a good approach?

Ask for help

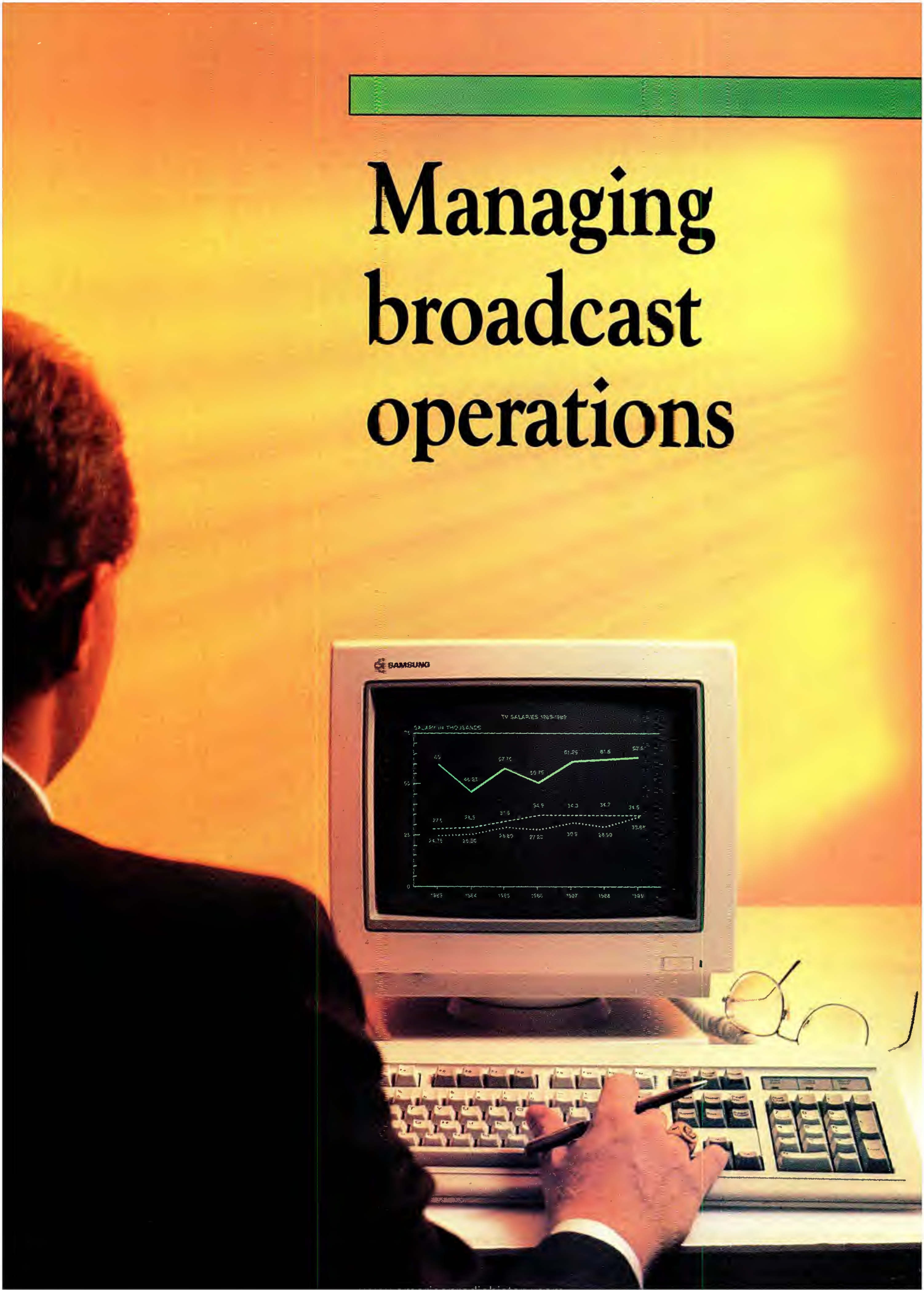
When you're trying to influence another person, *I* statements work well. Here are two examples:

- "I realize you worked on camera four yesterday, but it failed again during the 10 p.m. strip. I really looked bad in front of the GM this morning when he called me on it."
- "I've tried to adjust your schedule around your softball games, John, but asking me to change it again at this late date is unrealistic. Now I'm being asked to justify the schedule changes to the personnel department."

The *I* message helps identify you as a person with feelings (and problems). Such communication sometimes is perceived as *a plea for help*. How do you respond when someone asks for help? Most of us want to help. With *I* statements, you're trying to get that person to change behavior to meet your needs.

Next month, we'll conclude this series on leadership skills by working through some examples of problems. Until then, practice using *I* instead of *you* statements when you want another's behavior to change. [BE]

Managing broadcast operations



Broadcast engineer or brontosaurus? You decide.

A.D. 2000: "Broadcast engineers are declared an endangered species."

What do you think? Could it happen?

Broadcast engineers are not becoming extinct, although a few vocal ones would have you think so. Admittedly, the craft has changed greatly in the past few years as deregulation has worked its way through radio and TV stations.

Today's broadcast engineers operate in a freer environment than their counterparts of 20 years ago. Gone are the straitjacket regulations of yesteryear. Also gone are the days when the broadcast engineer could command respect under the guise of being the only one who knew what each piece of equipment did. Playing king of the electronic mountain won't work today.

Despite the many changes, broadcast engineering is even more important to a station's success than ever before. In the old days, the main job of the engineer was to keep the station on the air. Today, staying on the air is usually not the problem. The problem is keeping up with the competition from other stations and new technologies. This requires a different set of skills.

Today's chief engineers must be sharper than ever before. It's no longer possible to make it to the top simply by knowing how to repair equipment. You can't be just a good electronic engineer. You now must be a good manager, too. This means being able to manage resources, which include both people and technology.

This month's feature section highlights some of the significant changes in broadcast engineering. Combined, the articles will help you better understand some of these changes and how to take advantage of them.

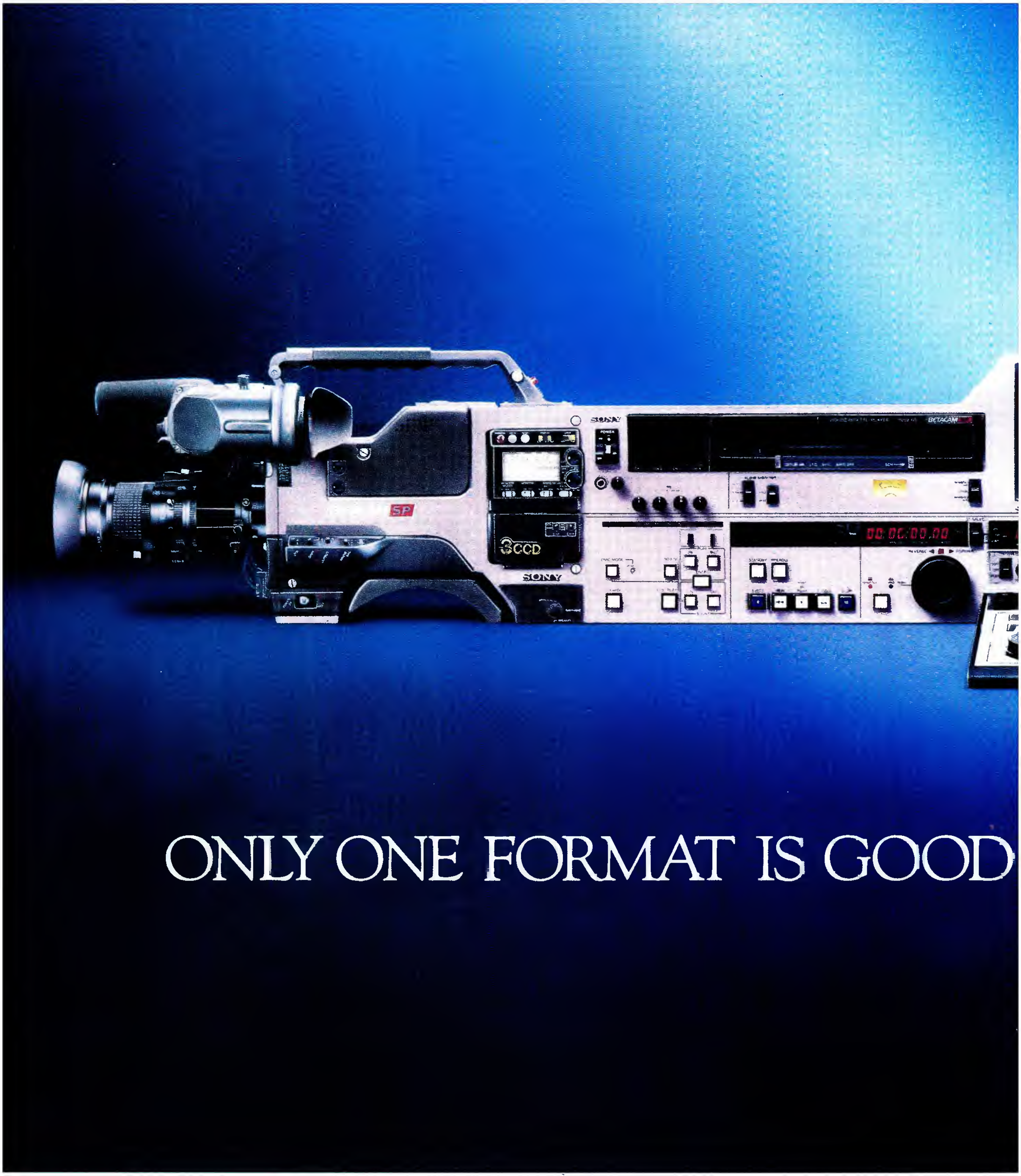
The first article in the series is the annual salary survey. Stop here, and find out how you are doing. Are you ahead or behind? How does your paycheck stack up against your competitors'?

The next two articles deal with AM stereo. Reading the first one may help you convince your manager to make the conversion. The technology is there, so why not take advantage of it? The second article will provide insights into why technology alone no longer sets the pace of change.

Broadcast engineers are not going the way of the dinosaur. They're just evolving into higher-skilled professionals. Don't be left behind.

Brad Dick

Brad Dick,
issue editor



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The 1989 salary survey: dividing the pie

By Brad Dick, technical editor

TV engineers may find it hard to swallow their shrinking share of the pie this year.

Don't look for big changes in your paycheck. This year's salary survey shows that most salaries are up, but just a little.

That's good news, given some of what we've seen in previous years. The cooling economy and tight broadcast budgets have combined to restrain the size of increases paid to broadcast personnel. The good news is that this year's percentage increases generally are larger than last year's. The bad news is that even a small increase would be good news for the TV engineers.

Tabular results

The survey results are summarized in Tables 1 through 7. Tables 1 through 3 contain the major portion of the data collected in the survey. You can use these tables to make detailed comparisons as they relate to your situation.

Tables 4 and 5 summarize the median salary information for both radio and TV stations over the past two years. Information about non-commercial stations was broken out for the first time in last year's survey results. Those of you working in these stations now have a 2-year overview.

The information presented is based on *median* salaries. *Average* salaries may be quite different from median salaries. From a statistical comparison standpoint, median values are more meaningful. The median salary represents the salary midpoint where salaries are ranked from smallest to largest. Half the respondents will earn more than the median value, and half will earn less.

The 1989 **BE** salary survey was conducted scientifically by the marketing research department of Intertec Publishing. On June 15, 3,000 questionnaires were mailed to recipients of **BE** on an "nth name" basis. By Aug. 4, 878 completed forms had been returned, providing a response rate of 29.3%. The data contained within this report is based on those responses.

Slow upward growth

Compared across all markets, radio and TV salaries have increased from last year. The upward trend of radio salaries continues at about the same pace as last year. Unfortunately, a disquieting trend continues in TV engineering salaries. For the past three years, salaries for TV engineers have shown little change.

All but two categories (corporate radio and TV engineering) follow a similar pattern. A high, but single-digit, percentage increase was received in 1987. In 1988, the percent increase dropped by one-half. In 1989, the percent of salary increase has returned to about the same amount as in 1987.

When graphed, the changes closely resemble a "V." This trend holds true for radio operators and engineers and TV corporate and operation staffs. The graph for corporate radio staff is a steady but upward straight line. Graphing the same information for TV engineering shows a negative percentage change in 1987 followed by a small increase in 1988. Adding the 1989 data to the graph results in slight, but downward, movement (an inverted "V"). This is another sign that TV engineering salaries are going the wrong direction.

For the first time, TV operator salaries are almost equal to TV engineering salaries. If this trend continues, TV operator salaries will exceed TV engineering salaries next year. As usual, corporate TV salaries are twice those of TV engineers.

Market-size analysis

Looking at salaries by market size reveals some interesting results. Here we see some significant increases (and a few decreases) in paychecks.

Measured over all markets, radio corporate salaries increased by 4%. In the below top 100 markets, however, they increased by 17%. Even non-commercial managers received healthy increases, with a median value of 8%.

Radio engineering salaries show an increase across all market sizes. Increases range from 2%, in the below top 100 markets, to 22% in the top 100 markets. Noncommercial radio engineering salaries rose 13%. Measured across all markets, radio engineering salaries increased 9%.

The results for radio operators were mixed. Non-commercial radio operators

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TABLE 1. — MANAGEMENT STAFF PROFILE*

	ALL MARKETS	TELEVISION					RADIO				
Management	Total %	Total TV %	Top 50 %	Top 100 %	Below Top 100 %	Non-Comm. %	Total Radio %	Top 50 %	Top 100 %	Below Top 100 %	Non-Comm. %
Salary Level											
Less than $15,000	3.7	2.0	....	....	....	4.3	4.5	....	28.6	3.5	2.8
$15,000 to $24,999	13.6	2.0	....	....	....	4.3	18.8	8.3	28.6	17.5	22.2
$25,000 to $34,999	22.2	8.0	....	14.3	....	13.0	28.6	33.3	14.3	28.1	30.6
$35,000 to $49,999	21.6	18.0	10.0	28.6	10.0	21.7	23.2	....	....	21.1	38.9
$50,000 to $74,999	21.6	40.0	40.0	28.6	50.0	39.1	13.4	25.0	14.3	15.8	5.6
$75,000 or more	16.0	30.0	50.0	28.6	40.0	17.4	9.8	33.3	14.3	10.5	....
No response	1.2	....	....	....	....	....	1.8	....	....	3.5	....
Median =	$42,100	$63,125	$75,000	$62,500	$72,500	$55,550	$34,200	$62,500	$25,000	$35,000	$33,650
Received Salary Increase During Past Year	56.2	76.0	80.0	71.4	50.0	87.0	47.3	41.7	42.9	35.1	69.4
Percentage of increase											
Less than 3%	1.9	2.0	....	....	....	4.3	1.8	....	....	3.5	....
3% to 4%	8.6	14.0	20.0	....	....	21.7	6.3	....	....	....	19.4
5% to 9%	29.0	44.0	40.0	71.4	10.0	52.2	22.3	25.0	28.6	15.8	30.6
10% to 14%	10.5	12.0	10.0	....	40.0	4.3	9.8	8.3	....	10.5	11.1
15% or more	5.6	4.0	10.0	....	....	4.3	6.3	8.3	14.3	3.5	8.3
No response	0.7	....	....	....	....	....	0.9	....	....	1.8	....
Median =	7.4	6.3	6.5	7.0	10.5	5.9	7.9	7.0	9.0	8.0	7.3
Fringe Benefits Received (Adds to more than 100% due to multiple answers)											
Medical insurance (paid)	82.7	94.0	90.0	71.4	100.0	100.0	77.7	83.3	71.4	73.7	83.3
Dental insurance (paid)	38.9	50.0	50.0	42.9	60.0	47.8	33.9	58.3	14.3	21.1	50.0
Life insurance (paid)	64.8	86.0	90.0	85.7	90.0	82.6	55.4	66.7	57.1	45.6	66.7
Sick leave	82.1	94.0	90.0	85.7	100.0	95.7	76.8	83.3	71.4	64.9	94.4
Vacation	91.4	98.0	100.0	85.7	100.0	100.0	88.4	91.7	85.7	84.2	94.4
Stock purchase plan	4.3	....	....	....	....	....	6.3	16.7	....	7.0	2.8
Profit sharing plan	10.5	10.0	10.0	14.3	20.0	4.3	10.7	25.0	28.6	12.3	....
Savings plan	8.6	18.0	40.0	14.3	10.0	13.0	4.5	8.3	....	3.5	5.6
Pension plan	42.0	62.0	60.0	28.6	40.0	82.6	33.0	25.0	14.3	8.8	77.8
Bonus	25.3	28.0	50.0	28.6	70.0	....	24.1	41.7	28.6	33.3	2.8
Trade show/convention/ seminar expenses paid	54.9	62.0	60.0	57.1	90.0	52.2	51.8	50.0	57.1	47.4	58.3
Tuition refund plan	25.9	36.0	40.0	14.3	10.0	52.2	21.4	8.3	14.3	3.5	55.6
Automobile furnished	39.5	40.0	50.0	42.9	90.0	13.0	39.3	58.3	57.1	54.4	5.6
Other	11.7	6.0	....	14.3	10.0	4.3	14.3	16.7	28.6	14.0	11.1
No response	2.5	2.0	....	14.3	....	....	2.7	....	14.3	3.5	....
Years in Present Job											
1 to 2	16.7	16.0	....	28.6	10.0	21.7	17.0	16.7	42.9	14.0	16.7
3 to 4	21.0	24.0	50.0	14.3	20.0	17.4	19.6	8.3	14.3	15.8	30.6
5 to 9	22.8	16.0	....	28.6	20.0	17.4	25.9	33.3	28.6	24.6	25.0
10 to 14	13.6	16.0	20.0	....	10.0	21.7	12.5	8.3	14.3	12.3	13.9
15 to 24	16.0	18.0	10.0	28.6	20.0	17.4	15.2	8.3	....	21.1	11.1
25 or more	9.9	10.0	20.0	....	20.0	4.4	9.8	25.0	....	12.3	2.8
No response	....	....	....	....	....	....	....	....	....	....	....
Median =	7.3	8.3	7.0	6.0	10.0	7.0	7.2	7.0	3.0	8.0	5.5
Years in Broadcast Industry											
Less than 5	3.7	2.0	....	....	....	4.4	4.5	....	....	....	13.9
5 to 9	3.1	....	....	....	....	....	4.5	....	....	7.0	2.8
10 to 14	9.9	4.0	10.0	14.3	....	....	12.5	....	14.3	7.0	25.0
15 to 24	33.3	40.0	30.0	42.9	30.0	47.8	30.4	50.0	28.6	26.3	30.6
25 or more	50.0	54.0	60.0	42.9	70.0	47.8	48.2	50.0	57.1	59.6	27.8
No response	....	....	....	....	....	....	....	....	....	....	....
Median =	24.5	25.5	27.0	22.0	31.5	24.0	23.5	26.5	30.0	27.8	15.5
Do Part-Time or Free-Lance Work											
Yes	32.1	20.0	20.0	14.3	20.0	21.7	37.5	25.0	71.4	28.1	50.0
No	66.7	80.0	80.0	85.7	80.0	78.3	60.7	75.0	28.6	68.4	50.0
No response	1.2	....	....	....	....	....	1.8	....	....	3.5	....
Education											
High school	9.3	....	....	....	....	....	13.4	....	14.3	24.6	....
Some college	23.5	16.0	20.0	28.6	....	17.4	26.8	50.0	28.6	31.6	11.1
College grad (bachelor's degree)	37.0	46.0	60.0	57.1	80.0	21.7	33.0	33.3	42.9	31.6	33.3
College grad (master's, Ph.D.)	27.8	36.0	20.0	14.3	20.0	56.5	24.1	16.7	14.3	7.0	55.6
Technical school	14.2	10.0	10.0	14.3	10.0	8.7	16.1	25.0	14.3	22.8	2.8
Other	1.9	....	....	....	....	....	2.7	8.3	....	1.8	2.8
No response	....	....	....	....	....	....	....	....	....	....	....
Age, Years											
Under 25	0.6	....	....	....	....	....	0.9	....	....	....	2.8
25 to 34	13.0	4.0	....	14.3	....	4.4	17.0	16.7	....	12.3	27.8
35 to 44	27.8	26.0	20.0	28.6	30.0	26.1	28.6	25.0	28.6	29.8	27.8
45 to 54	33.3	34.0	40.0	14.3	20.0	43.5	33.0	16.7	28.6	35.1	36.1
55 to 64	18.5	30.0	40.0	28.6	40.0	21.7	13.4	33.3	28.6	12.3	5.6
65 or over	6.8	6.0	....	14.3	10.0	4.4	7.1	8.3	14.3	10.5	....
No response	....	....	....	....	....	....	....	....	....	....	....
Median =	47.7	51.2	53.8	50.0	54.5	50.0	47.0	50.0	52.5	47.5	42.5

*Management staff: president, owner, partner, vice president, general manager.

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TABLE 2. — ENGINEERING AND TECHNICAL STAFF PROFILE*

	ALL MARKETS	TELEVISION					RADIO				
Engineering	Total %	Total TV %	Top 50 %	Top 100 %	Below Top 100 %	Non-Comm. %	Total Radio %	Top 50 %	Top 100 %	Below Top 100 %	Non-Comm. %
Salary Level											
Less than $15,000	7.3	2.7	1.0	12.0	5.1	1.1	12.3	3.8	3.8	21.1	16.7
$15,000 to $24,999	23.3	20.0	7.7	8.0	48.8	25.2	26.8	12.8	30.8	40.8	26.7
$25,000 to $34,999	27.8	28.3	20.2	48.0	28.2	32.3	27.2	19.2	38.5	26.8	33.3
$35,000 to $49,999	27.1	27.8	28.8	32.0	12.8	32.3	26.5	46.3	26.9	9.9	20.0
$50,000 to $74,999	13.3	18.8	37.5	. . . .	5.1	8.0	7.2	17.9	. . . .	1.4	3.3
$75,000 or more	0.8	1.6	3.8	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
No response	0.4	0.8	1.0	. . . .	. . . .	1.1	. . . .	. . . .	. . . .	. . . .	. . . .
Median =	$31,900	$34,500	$45,800	$31,300	$24,250	$32,100	$29,000	$39,650	$29,000	$21,750	$27,000
Received Salary Increase During Past Year	67.8	75.7	76.0	80.0	69.2	77.0	59.1	73.1	42.3	45.1	66.7
Percentage of increase											
Less than 3%	6.3	9.4	10.6	16.0	7.7	6.9	3.0	2.6	. . . .	7.1	. . . .
3% to 4%	22.5	27.5	33.6	24.0	25.5	21.8	17.0	18.0	11.5	14.1	21.7
5% to 9%	28.8	29.4	23.1	36.0	15.4	41.5	27.9	37.1	23.2	14.1	35.0
10% to 14%	5.1	4.3	4.8	4.0	7.7	2.3	6.0	6.4	3.8	4.2	8.3
15% or more	4.1	3.9	2.9	. . . .	10.3	3.4	4.3	6.4	. . . .	5.6	1.7
No response	1.0	1.2	1.0	. . . .	2.6	1.1	0.9	2.6	3.8	. . . .	. . . .
Median =	5.8	5.1	4.6	5.0	5.0	6.1	6.7	7.4	6.7	5.5	6.7
Fringe Benefits Received (Adds to more than 100% due to multiple answers)											
Medical insurance (paid)	83.7	88.2	89.4	84.0	84.6	89.7	78.7	88.5	80.8	69.0	76.7
Dental insurance (paid)	48.6	54.5	65.4	32.0	38.5	55.2	42.1	62.8	26.9	19.7	48.3
Life insurance (paid)	60.8	64.3	60.6	56.0	56.4	74.7	57.0	66.7	61.5	45.1	56.7
Sick leave	84.5	92.5	90.4	92.0	89.7	96.6	75.7	84.6	65.4	62.0	85.0
Vacation	96.1	98.0	96.2	96.0	100.0	100.0	94.0	93.6	96.2	94.4	93.3
Stock purchase plan	13.3	18.0	32.7	28.0	7.7	2.3	8.1	19.2	3.8	2.8	1.7
Profit sharing plan	13.3	16.5	25.0	28.0	20.5	1.1	9.8	17.9	19.2	5.6	. . . .
Savings plan	20.4	25.5	41.3	32.0	5.1	13.8	14.9	30.8	7.7	1.4	13.3
Pension plan	50.0	63.1	62.5	36.0	43.6	80.5	35.7	42.3	23.1	7.0	66.7
Bonus	11.8	7.1	11.5	8.0	7.7	1.1	17.0	26.9	7.7	15.5	10.0
Trade show/convention/ seminar expenses paid	33.3	27.5	26.0	24.0	15.4	35.6	39.6	39.7	34.6	33.8	48.3
Tuition refund plan	31.0	36.1	48.1	24.0	10.3	36.8	25.5	33.3	11.5	2.8	48.3
Automobile furnished	14.1	10.6	10.6	12.0	17.9	6.9	17.9	19.2	38.5	19.7	5.0
Years in Present Job											
1 to 2	21.4	21.2	18.2	24.0	25.6	21.8	21.7	24.4	26.9	19.7	18.3
3 to 4	13.7	9.8	11.5	12.0	2.6	10.3	17.9	28.1	3.8	12.7	16.7
5 to 9	30.6	32.9	37.5	20.0	28.2	32.3	28.5	24.4	30.8	31.0	30.0
10 to 14	13.1	12.6	16.4	12.0	5.1	11.5	13.6	10.3	15.4	14.1	16.7
15 or more	21.2	23.5	16.1	32.0	38.5	24.1	18.3	12.8	23.1	22.5	18.3
Median =	7.5	7.9	7.8	8.5	8.9	7.8	6.8	4.8	8.2	7.8	7.5
Years in Broadcast Industry											
Less than 5	6.7	8.6	6.7	8.0	12.8	9.2	4.7	2.6	. . . .	4.2	10.0
5 to 9	16.1	18.4	18.3	16.0	20.5	18.4	13.6	15.4	3.8	14.1	15.0
10 to 14	21.2	22.4	29.7	24.0	15.4	16.1	20.0	19.2	26.9	22.5	15.0
15 to 24	31.7	29.4	28.9	24.0	20.5	37.9	34.0	33.3	42.4	28.2	38.3
25 or more	24.3	21.2	16.4	28.0	30.8	18.4	27.7	29.5	26.9	31.0	21.7
Median =	16.9	15.2	24.2	16.3	15.7	17.1	18.2	18.4	18.6	19.1	17.3
Do Part-Time or Free-Lance Work											
Yes	47.3	38.8	38.5	40.0	38.5	39.1	56.6	60.3	42.3	59.2	55.0
No	52.3	60.8	60.5	60.0	61.5	60.9	43.0	39.7	57.7	39.4	45.0
No response	0.4	0.4	1.0	. . . .	. . . .	. . . .	0.4	. . . .	. . . .	1.4	. . . .
Education											
High school	15.1	15.3	10.6	24.0	25.6	13.8	14.9	14.1	30.8	18.3	5.0
Some college	39.6	40.0	39.4	24.0	48.7	41.4	39.1	46.2	30.8	36.6	36.7
College grad (bachelor's degree)	29.8	29.4	36.5	24.0	12.8	29.9	30.2	33.3	19.2	22.5	40.0
College grad (master's, Ph.D.)	3.1	1.2	1.0	4.0	. . . .	1.1	5.1	1.3	7.7	4.2	10.0
Technical school	44.9	49.8	50.0	52.0	51.3	48.3	39.6	38.5	42.3	43.7	35.0
Other	5.3	5.5	2.9	4.0	12.8	5.7	5.1	2.6	3.8	9.9	3.3
No response	0.2	0.4	. . . .	0.4	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Age, Years											
Under 25	2.9	4.3	3.8	8.0	5.1	3.4	1.3	1.3	. . . .	1.4	1.7
25 to 34	29.8	29.8	33.7	32.0	28.3	25.3	29.8	35.9	30.8	28.2	23.3
35 to 44	34.8	35.3	33.7	28.0	33.3	40.3	34.5	32.1	42.3	32.4	36.7
45 to 54	19.6	18.8	19.2	8.0	20.5	20.7	20.4	19.2	15.4	23.9	20.0
55 to 64	10.0	9.4	6.7	12.0	12.8	10.3	10.6	7.7	11.5	9.9	15.0
65 or over	2.7	2.0	2.9	8.0	. . . .	. . . .	3.4	3.8	. . . .	4.2	3.3
No response	0.2	0.4	. . . .	4.0	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Median =	39.9	39.4	38.3	37.9	40.0	40.3	40.5	39.0	39.5	41.3	41.8

*Engineering staff: technical manager, chief engineer, engineer.

TABLE 3. — OPERATIONS STAFF PROFILE*

	ALL MARKETS	TELEVISION					RADIO				
Operations	Total %	Total TV %	Top 50 %	Top 100 %	Below Top 100 %	Non-Comm. %	Total Radio %	Top 50 %	Top 100 %	Below Top 100 %	Non-Comm. %
Salary Level											
Less than $15,000	5.3	0.8	....	....	5.0	....	10.5	....	....	17.6	9.1
$15,000 to $24,999	35.8	24.0	10.5	15.8	50.0	27.3	49.5	30.4	55.6	54.9	54.6
$25,000 to $34,999	29.2	28.9	15.8	36.8	15.0	43.2	29.5	39.1	44.4	21.6	31.8
$35,000 to $49,999	18.6	28.9	34.2	36.8	25.0	22.7	6.7	21.7	....	3.9	....
$50,000 to $74,999	8.0	13.2	26.3	10.5	5.0	6.8	1.9	4.3	....	2.0	....
$75,000 or more	3.1	4.1	13.2	....	....	....	1.9	4.3	....	....	4.5
No response	....	....	....	....	....	....	....	....	....	....	....
Median =	$28,100	$33,850	$45,950	$35,000	$24,150	$30,500	$23,600	$30,550	$25,000	$21,750	$23,750
Received Salary Increase During Past Year	75.7	79.3	84.2	68.4	70.0	84.1	71.4	82.6	44.4	66.7	81.8
Percentage of increase											
Less than 3%	4.0	3.3	2.6	....	....	6.8	4.8	....	11.1	7.8	....
3% to 4%	19.9	25.6	28.9	36.8	30.0	15.9	13.3	26.1	....	7.8	18.2
5% to 9%	35.8	38.8	42.1	31.6	15.0	50.0	32.4	43.5	11.1	23.5	50.0
10% to 14%	8.0	8.3	7.9	....	15.0	9.1	7.6	4.3	....	13.7	....
15% or more	6.6	2.5	2.6	....	5.0	2.3	11.4	8.7	22.2	9.8	13.6
No response	1.3	0.8	....	....	5.0	....	1.9	....	....	3.9	....
Median =	5.7	5.5	5.6	4.9	5.5	5.6	5.9	5.8	NA	6.8	7.8
Fringe Benefits Received (Adds to more than 100% due to multiple answers)											
Medical insurance (paid)	81.9	86.8	89.5	84.2	85.0	86.4	76.2	91.3	44.4	72.5	81.8
Dental insurance (paid)	49.6	66.9	76.3	63.2	65.0	61.4	29.5	43.5	44.4	15.7	40.9
Life insurance (paid)	58.4	70.2	73.7	63.2	70.0	70.5	44.8	60.9	44.4	39.2	40.9
Sick leave	84.1	90.9	92.1	89.5	90.0	90.9	76.2	78.3	88.9	70.6	81.8
Vacation	94.2	95.9	97.4	94.7	95.0	95.5	92.4	95.7	88.9	94.1	86.4
Stock purchase plan	11.9	14.9	34.2	21.1	5.0	....	8.6	21.7	....	7.8	....
Profit sharing plan	10.2	14.0	26.3	15.8	15.0	2.3	5.7	13.0	....	5.9	....
Savings plan	23.0	33.9	50.0	26.3	25.0	27.3	10.5	30.4	11.1	2.0	9.1
Pension plan	43.4	57.9	63.2	36.8	40.0	70.5	26.7	34.8	33.3	11.8	50.0
Bonus	23.0	27.3	42.1	47.4	35.0	2.3	18.1	17.4	22.2	25.5	....
Trade show/convention/ seminar expenses paid	33.2	39.7	44.7	36.8	25.0	43.2	25.7	26.1	33.3	25.5	22.7
Tuition refund plan	26.5	38.8	39.5	36.8	20.0	47.7	12.4	13.0	11.1	2.0	36.4
Automobile furnished	5.8	7.4	2.6	5.3	30.0	2.3	3.8	....	11.1	5.9	....
Other	8.0	8.3	10.5	10.5	10.0	4.5	7.6	13.0	....	9.8	....
No response	3.1	0.8	....	....	5.0	....	5.7	....	11.1	5.9	9.1
Years in Present Job											
1 to 2	27.4	24.0	18.4	42.1	25.0	20.5	31.4	43.5	22.2	27.5	31.8
3 to 4	25.7	29.8	26.3	31.6	55.0	20.5	21.0	8.7	33.3	21.6	27.3
5 to 9	23.0	23.1	39.5	21.1	10.0	15.9	22.8	17.4	22.2	23.5	27.3
10 to 14	12.4	13.2	10.5	....	5.0	25.0	11.4	17.4	11.1	11.8	4.5
15 to 24	8.8	7.4	....	5.3	5.0	15.9	10.5	13.0	11.1	9.8	9.1
25 or more	2.7	2.5	5.3	....	....	2.3	2.9	....	....	5.9	....
No response	....	....	....	....	....	....	....	....	....	....	....
Median =	4.7	4.7	5.4	3.5	3.8	5.5	4.8	4.0	4.5	5.3	3.9
Years in Broadcast Industry											
Less than 5	5.8	6.6	2.6	5.3	5.0	11.4	4.8	4.3	....	2.0	13.6
5 to 9	19.0	17.4	13.2	26.3	25.0	13.6	21.0	8.7	22.2	19.6	36.4
10 to 14	24.8	24.8	18.4	21.1	40.0	25.0	24.8	26.1	33.3	29.4	9.1
15 to 24	37.2	38.8	52.6	42.1	30.0	29.5	35.2	43.5	22.2	35.3	31.8
25 or more	13.3	12.4	13.2	5.3	....	20.5	14.3	17.4	22.2	13.7	9.1
No response	....	....	....	....	....	....	....	....	....	....	....
Median =	15.1	15.3	16.5	14.5	11.5	14.5	15.0	17.3	14.5	14.0	10.0
Do Part-Time or Free-Lance Work											
Yes	56.2	54.5	55.3	57.9	65.0	47.7	58.1	91.3	44.4	49.0	50.0
No	43.8	45.5	44.7	42.1	35.0	52.3	41.9	8.7	55.6	51.0	50.0
No response	....	....	....	....	....	....	....	....	....	....	....
Education											
High school	8.0	2.5	....	....	10.0	2.3	14.3	13.0	22.2	15.7	9.1
Some college	30.1	27.3	36.8	31.6	30.0	15.9	33.3	43.5	11.1	35.3	27.3
College grad (bachelor's degree)	46.9	50.4	55.3	36.8	50.0	52.3	42.9	39.1	55.6	43.1	40.9
College grad (master's, Ph.D.)	13.7	19.0	7.9	26.3	10.0	29.5	7.6	4.3	11.1	2.0	22.7
Technical school	13.7	9.9	10.5	5.3	10.0	11.4	18.1	13.0	33.3	19.6	13.6
Other	3.5	3.3	2.6	....	....	6.8	3.8	....	....	7.8	....
No response	....	....	....	....	....	....	....	....	....	....	....
Age, Years											
Under 25	2.7	0.8	....	....	....	2.3	4.8	....	....	3.9	13.6
25 to 34	42.0	36.4	23.7	47.4	55.0	34.1	48.6	39.1	55.6	51.0	50.0
35 to 44	37.6	46.3	65.8	47.4	35.0	34.1	27.6	43.5	22.2	21.6	27.3
45 to 54	14.6	12.4	5.3	5.3	5.0	25.0	17.1	13.0	11.1	23.5	9.1
55 to 64	3.1	4.1	5.3	....	5.0	4.5	1.9	4.3	11.1	....	....
65 or over	....	....	....	....	....	....	....	....	....	....	....
No response	....	....	....	....	....	....	....	....	....	....	....
Median =	36.5	37.9	39.2	36.1	34.5	39.3	34.4	38.0	34.0	34.2	32.7

*Operations staff: operations manager, station manager, production/program manager.

Continued on page 36

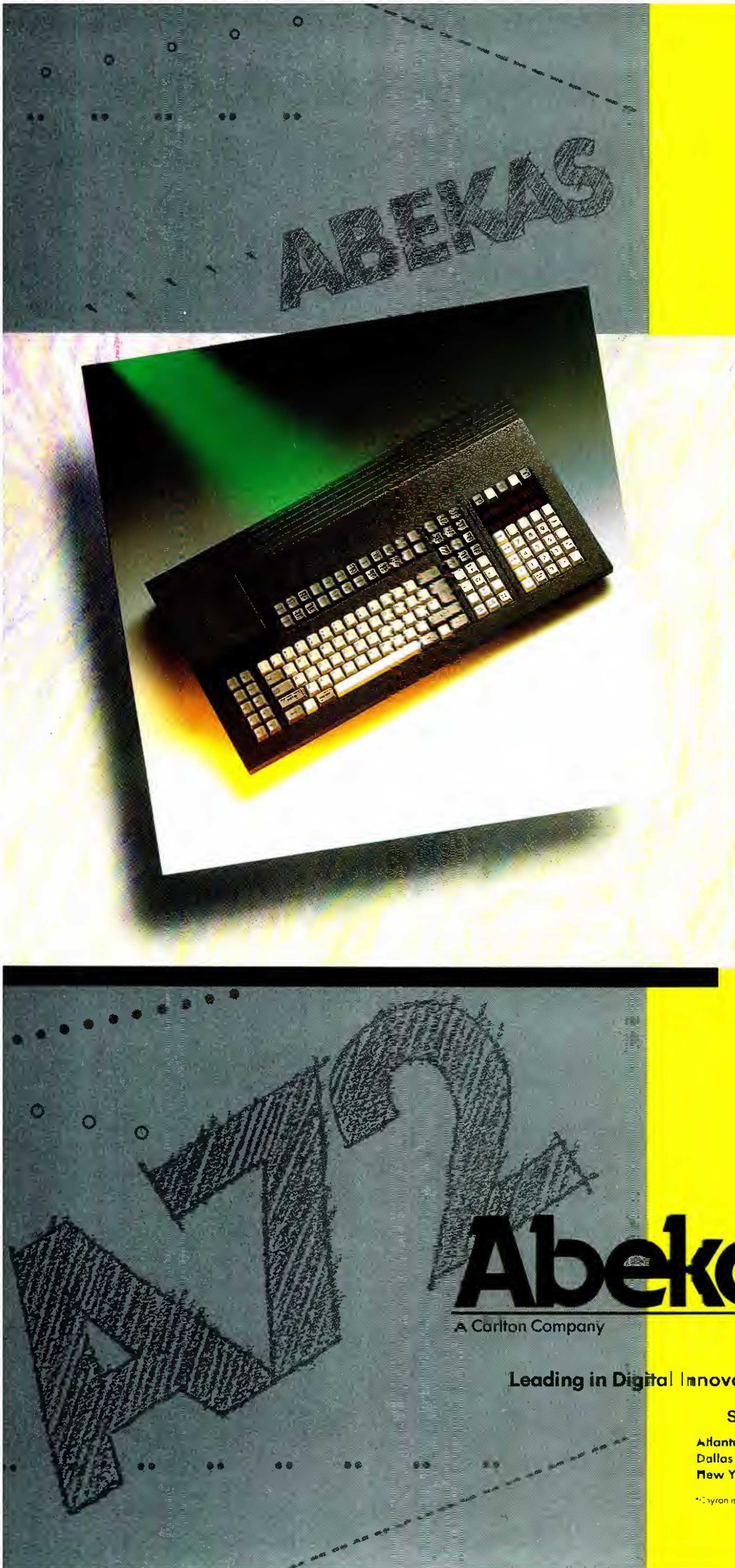

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TABLE 4. — MEDIAN SALARY SUMMARY FOR 1988 and 1989, TV

	1988 SURVEY					1989 SURVEY				
Category	**All Markets**	**Top 50**	**Top 100**	**Below Top 100**	**Non-Commercial**	**All Markets**	**Top 50**	**Top 100**	**Below Top 100**	**Non-Commercial**
Management	$61,500	$83,250	$75,000	$50,000	$53,000	$63,125	$75,000	$62,500	$72,500	$55,550
Engineering	$34,700	$42,350	$30,900	$27,700	$30,300	$34,500	$45,800	$31,300	$24,250	$32,100
Operations	$28,900	$39,200	$23,950	$19,450	$28,300	$33,850	$45,950	$35,000	$24,150	$30,500

TABLE 5. — MEDIAN SALARY SUMMARY FOR 1988 and 1989, RADIO

	1988 SURVEY					1989 SURVEY				
Category	**All Markets**	**Top 50**	**Top 100**	**Below Top 100**	**Non-Commercial**	**All Markets**	**Top 50**	**Top 100**	**Below Top 100**	**Non-Commercial**
Management	$33,000	$62,500	$37,550	$30,000	$31,200	$34,200	$62,500	$25,000	$35,000	$33,650
Engineering	$26,600	$37,550	$23,750	$21,250	$23,850	$29,000	$39,650	$29,000	$21,750	$27,000
Operations	$21,300	$27,800	$26,700	$18,600	$25,000	$23,600	$30,550	$25,000	$21,750	$23,750

TABLE 6. — MEDIAN SALARIES ACROSS ALL MARKETS

	TELEVISION				RADIO			
Category	**1986**	**1987**	**1988**	**1989**	**1986**	**1987**	**1988**	**1989**
Management	$50,750	$61,250	$61,500	$63,125	$31,400	$31,900	$33,000	$34,200
Engineering	$34,900	$34,300	$34,700	$34,500	$23,650	$25,800	$26,600	$29,000
Operations	$27,200	$30,900	$28,900	$33,850	$20,350	$20,950	$21,300	$23,600

TABLE 7. — MEDIAN VALUE PROFILE OF BROADCASTERS (Radio and TV Combined)

	MANAGEMENT			ENGINEERING			OPERATIONS		
Category	**1987**	**1988**	**1989**	**1987**	**1988**	**1989**	**1987**	**1988**	**1989**
Salary Level	$37,250	$42,500	$42,100	$29,800	$31,000	$31,900	$24,450	$24,200	$28,100
Received Salary Increase	44.2%	56.2%	56.2%	67.9%	74.6%	67.8%	70.6%	69.8%	75.7%
Amount of Increase	8.7%	7.6%	7.4%	6.5%	5.9%	5.8%	7.5%	6.7%	5.7%
Years in Present Job	8.6	6.7	7.0	6.1	6.4	7.5	3.9	4.5	4.2
Years in Broadcasting	22.8	21.2	26.0	16.1	16.3	16.9	13.5	13.8	15.4
Does Free-Lance Work	33.1%	28.1%	32.1%	47.5%	47.9%	47.3%	43.7%	50.4%	56.2%
College Graduate	62.9%	63.8%	64.8%	31.7%	30.5%	32.9%	62.7%	59%	60.6%
Age, Years	46.8	44.8	53.6	38.9	39.1	39.9	34.9	34.7	37.4

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saw a 5% decrease in the median salary. Salaries increased by 17% in the below top 100 markets. The top 50 markets are up 10%. Measured across all markets, the median salary increased 11%.

The picture for television is even less uniform. Corporate TV salaries are up in some markets, but the data available is not sufficient to develop a complete picture. Measured across all markets, corporate TV salaries are up 3%. Non-commercial TV corporate salaries are up 5%.

There is not much good news for TV engineers. The top 50 markets show an 8% increase, but the top 100 markets show only a 1% increase. The TV engineering median salary in the below top 100 markets dropped a whopping 12% — not good news to those engineers. Measured over all markets, the TV engineering median salary is down 1%. Last year's survey showed a mere 1% gain in this same category. Non-commercial TV engineering salaries rose 6%.

Now we come to TV operators. Based on this survey's results, TV operators must be having a party. Measured over all markets and in the top 50 markets, median salaries are up 17%. They are up from 8% in non-commercial stations to 24% in the below top 100 markets. No TV operator median salary rose less than 8% in this survey.

Move up to big money

Looking at salaries by market size can be disheartening to the broadcast employee who works in a smaller city. Moving from the below top 100 to the top 50 markets brings the radio engineer another $17,900. The same move for the TV engineer results in a $21,550 increase.

Similar moves by radio or TV operators show parallel changes. The radio operator median salary increases from $21,750 in the below top 100 markets (the same salary paid to engineers in this market) to $30,550 in the top 50 markets, a 40% increase.

Trends

Let's look at the history of median salaries based on the past six years of survey results. Figure 1 shows salaries reported for the radio categories from 1983 to 1989. The same information for TV salaries is shown in Figure 2. The results are based on results measured across all markets.

During this period, radio corporate salaries have increased by $5,600 (19.6%). Similar comparisons for radio engineers show an $8,150 increase (39%). The radio operators saw a $6,250, or 36%, increase.

Radio engineers received a 9% increase in 1987, a 3% increase in 1988 and a 9% increase this year. Similar comparisons for TV engineers show a quite different pattern.

In 1987, TV engineers saw a 2% drop in median salary. In 1988, the survey showed a 1% gain. This year, TV engineering salaries dropped again, by 1%. Here's what that equates to in dollars: In 1987, the TV engineering median salary was $34,300. In 1988, it rose to $34,700. This year, the 1% drop lowered the median salary to $34,500.

Both radio and TV operator median salaries showed the largest increase, up 11% in radio and up 17% in television. This

Continued on page 42

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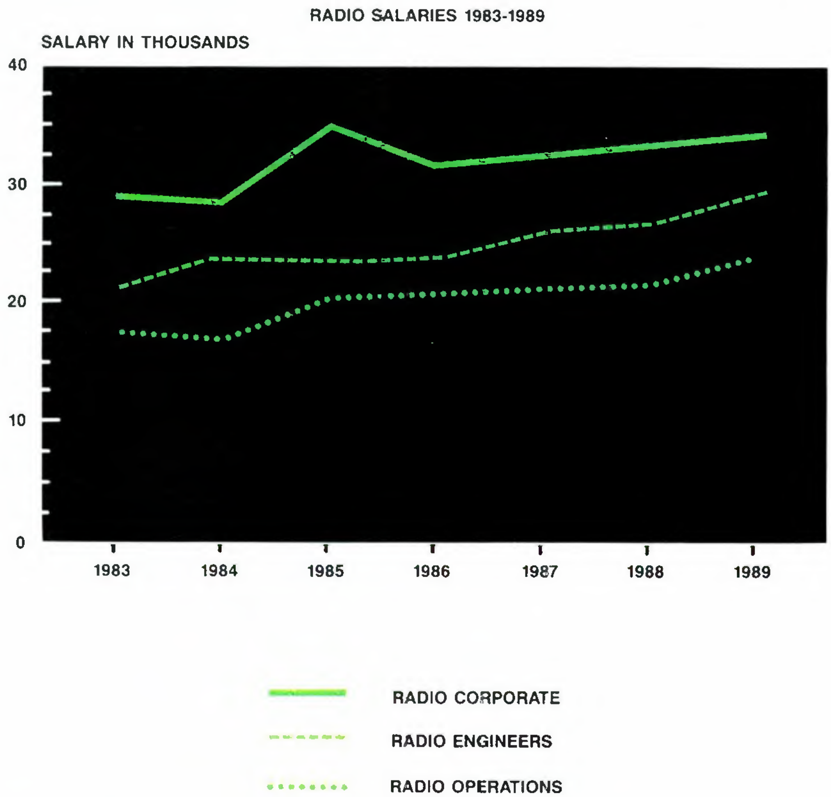


Figure 1. *Radio's median salaries measured over all markets for the period from 1983 to 1989.*

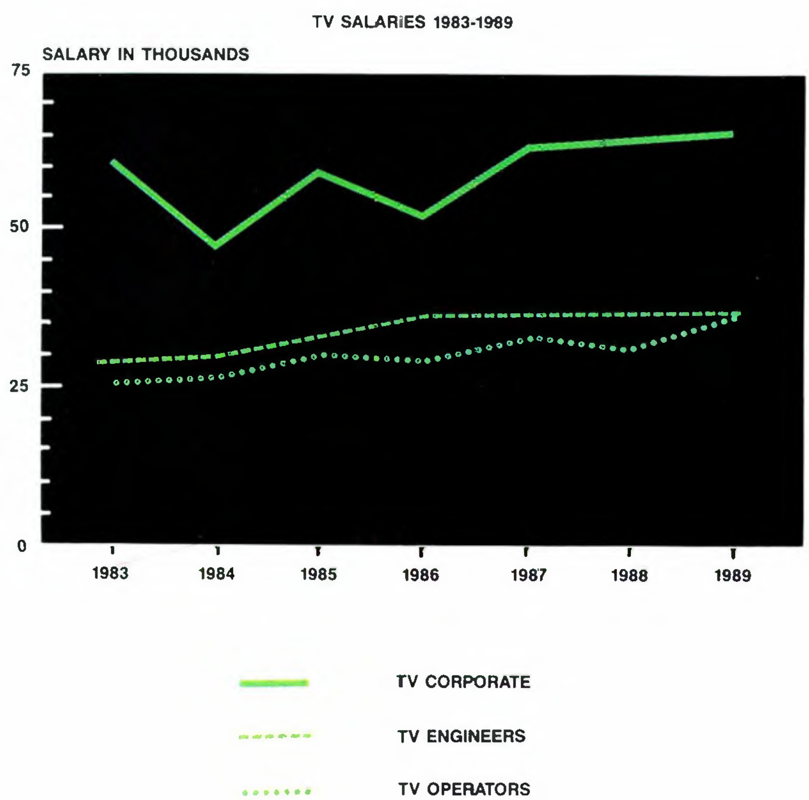


Figure 2. *Television's median salaries measured over all markets for the period from 1983 to 1989.*

Continued from page 38

may be the recovery year for TV operators. They lost 6% last year at the same time their radio counterparts saw only a 2% increase.

Slice of the pie

When making comparisons, it may be helpful to look at the percentages of respondents (radio and television combined) reporting by salary category. Figure 3 shows the percentage of corporate respondents with salaries in each of the listed categories. Similar results are shown for engineering salaries in Figure 4 and operator salaries in Figure 5.

The percentage of engineers who report earning from $25,000 to $35,000 is the same as last year. There was an increase in those earning less than $15,000. The number of respondents reporting salaries in the range of $15,000 to $25,000 rose by 3%. About 2% more engineers reported earning salaries in the $35,000-$50,000 range, as well as in the $50,000-$75,000 range.

Sizable changes showed up in the operator category. The percentage of respondents reporting median salaries less than $15,000 fell from 14.1% to 5.3%. Approximately the same percentage as last year (35.8%) report earnings in the $15,000-$25,000 range. There was an increase in the number reporting incomes in the higher salary categories. A total of 7% more respondents reported salaries in the $25,000-$35,000 category. This year, about 2% more respondents reported being in the next two higher salary categories.

The apparent shift upward in operator salaries confirms what we have already seen. If the trend continues, operators will become the second highest-paid job category within many stations.

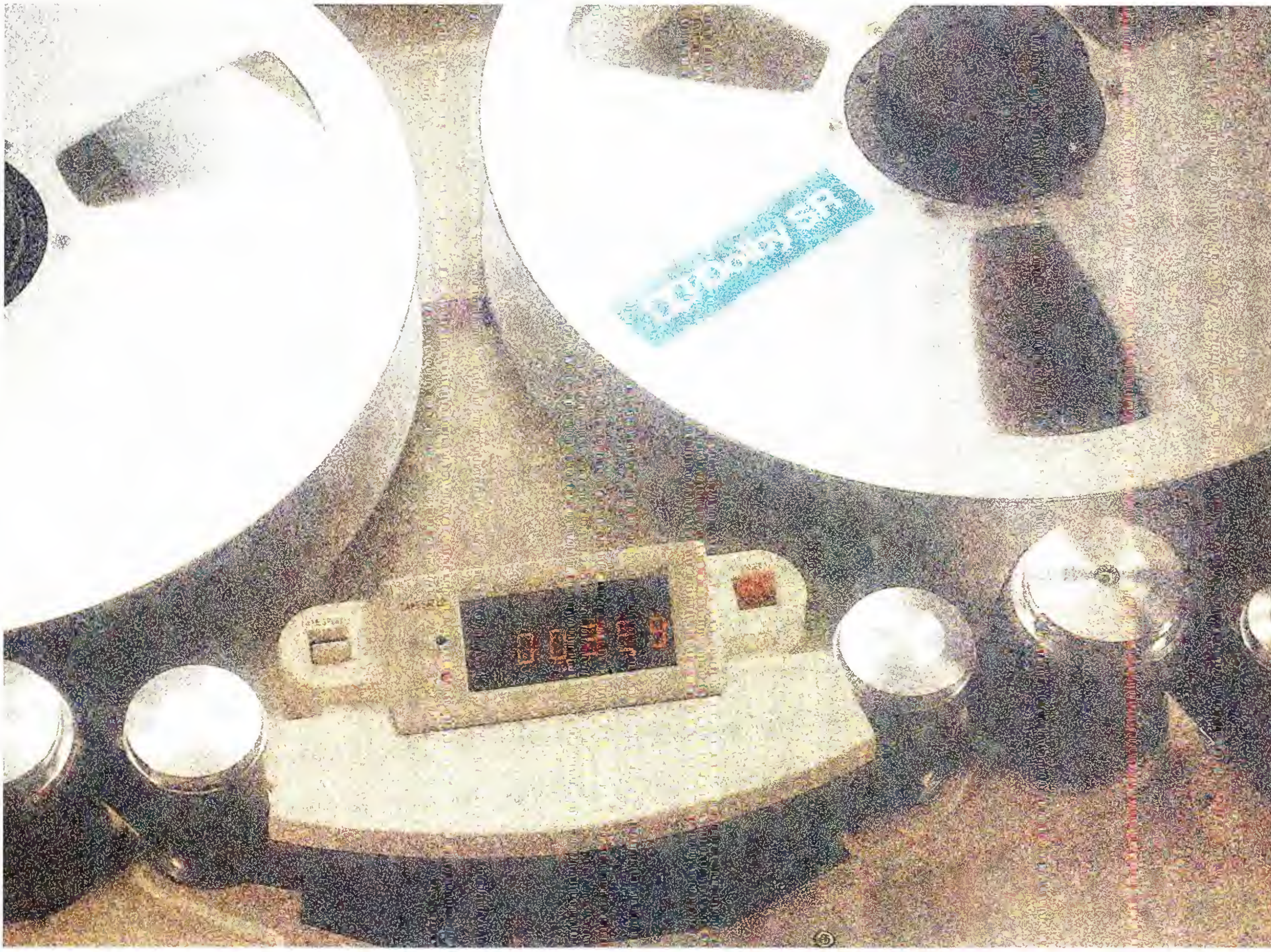
Opportunity exists

The 1989 **BE** salary survey may not provide the kind of information you'd like to present to your manager. Keep in mind that everyone else is facing similar conditions. Given the strength of this year's results, there is room for hope.

The increases are not large, but inflation isn't running wild either. Most of the deregulation already has taken place. The effects are evident, and stations are now better able to identify opportunities.

Some engineers will simply get out. They are not happy with the way the industry must operate. Over the years, two undeniable truths have surfaced repeatedly in the salary survey results.

The first is that a vocal group, but not a majority, of engineers will continue to complain about conditions and wish for the "good ol' days." They will lament the loss of the first-class license and beg for the FCC to return to heavy-handed regulation. That is not likely to happen.



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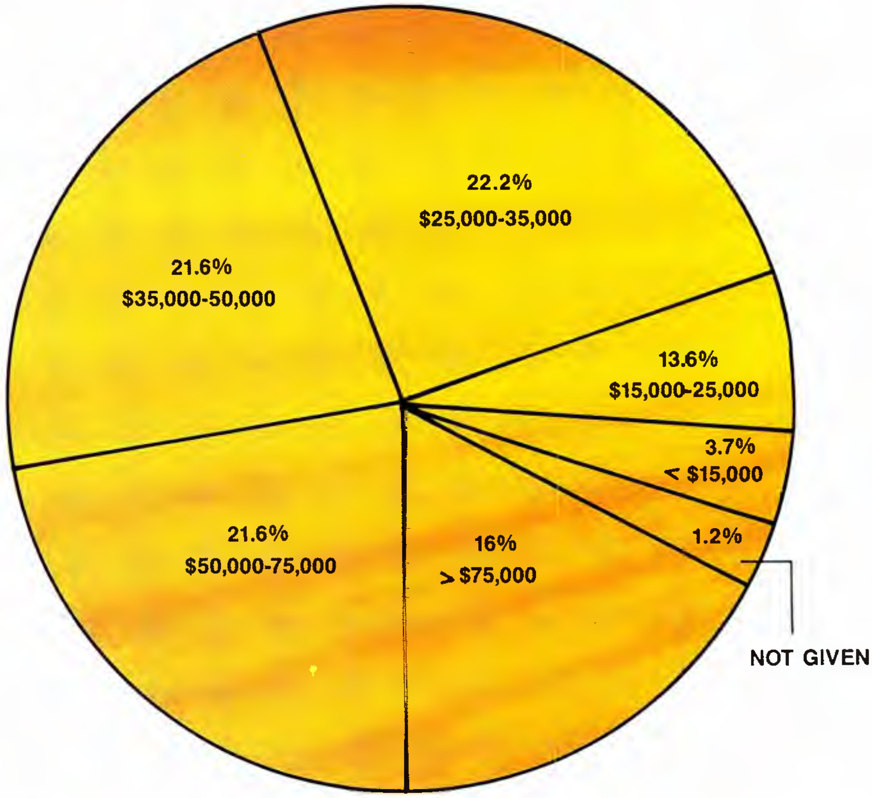

Figure 3. Percentage of management respondents listing a salary within the categories shown.

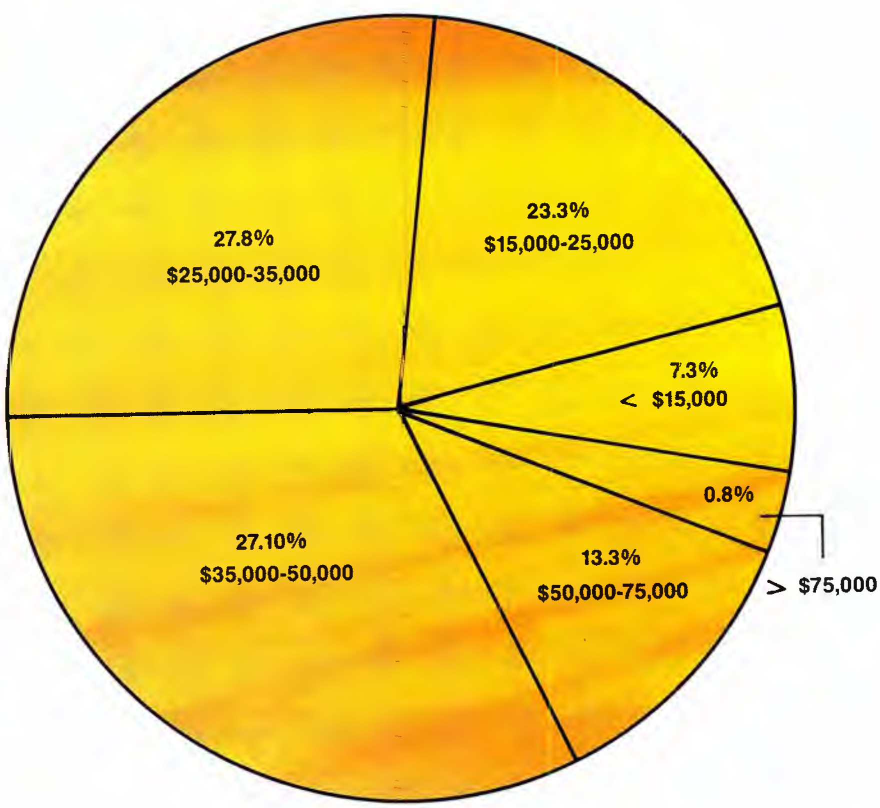

Figure 4. Percentage of engineering respondents listing a salary within the categories shown.

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Dependable, performing switchers from BTS. Anything else is substandard. Call for information and technical specifications today: **1-800-562-1136, ext. 21.**

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Second, there is a group of less vocal people (managers included) who see the changing nature of broadcasting as a challenge and opportunity. These people recognize that things will continue to change, and that the successful stations will take advantage of those changes.

Again and again, the survey shows that the successful engineers are those who can adapt to the current conditions. These people don't whine for more regulation — they simply look for ways to win under the current set of rules.

Continued on page 154

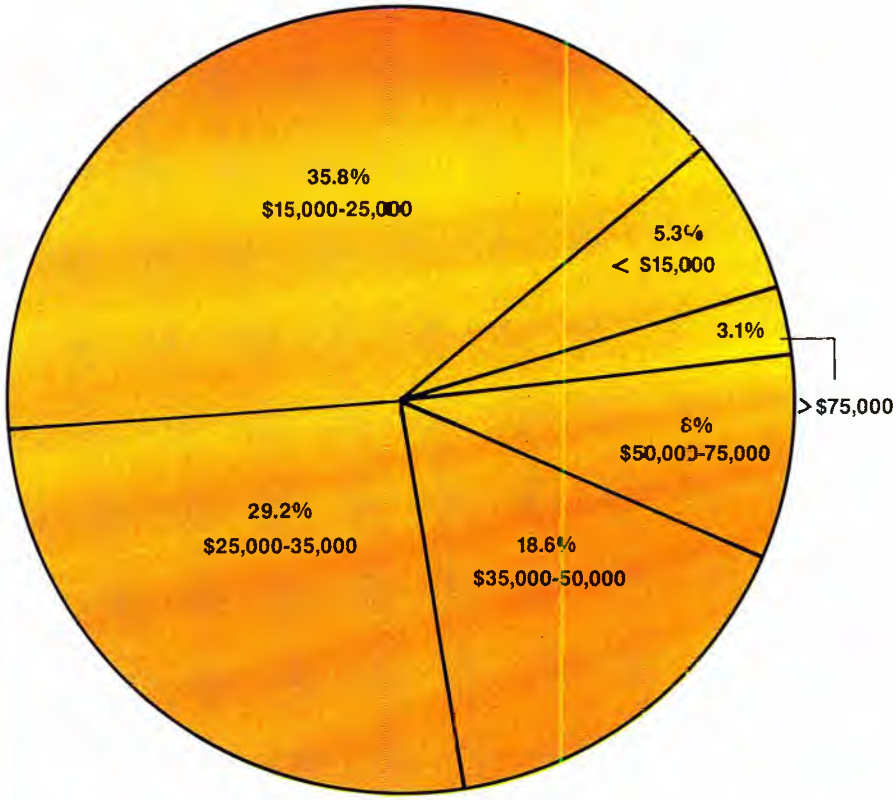

Figure 5. *Percentage of operations respondents listing a salary within the categories shown.*

Say what?

In a survey such as this, the number of negative comments is always greater than the number of positive ones. This year, there were not only more negative comments than usual, but the comments were worded more strongly than ever before. Many responded by writing in bold letters, red ink or capital letters to emphasize their concerns.

The topics commented on can be summarized into five categories, listed in descending order of frequency:

- Low pay.
- Lack of respect from management.
- Loss of jobs (and the accompanying use of per diem staffers).
- Management's single-minded attitude about profits.
- The shortage of trained engineers.

Many respondents blamed deregulation for the industry's condition. Radio respondents called for the FCC to reinstate the 3-year holding rule. Many of them also called for the FCC to take over operator/engineer licensing. There was a thread of concern about the states entering the area of broadcast licensing.

The TV engineers often mentioned the use of per diem employees as a threat. These engineers also said that continuing staff reduction was a major problem.

Radio management was concerned primarily about one thing: competition. Most comments from this category centered on the problems with more stations and fewer advertising dollars to go around.

The TV managers seemed concerned less about competition and more about staff. They commented about the need for versatile people who can handle a multitude of tasks as staffs are reduced.

Reading the comments was not an uplifting experience. The broadcast industry may not be going to hell in a hand basket, but you'd never know it by reading the survey comments. Here's how they went:

"There are fewer opportunities because fewer engineers are needed in stations. The trend says 'Get out.' "

"New, state-of-the-art equipment doesn't require as much maintenance; therefore, there is less of a challenge for competent engineers."

"Many engineers are leaving the industry because of actions of people who don't care about anything but money."

"Many well-established contract engineers are not keeping up with the newer technologies."

"I enjoy my work, but I'm leaving because there is no opportunity for upward mobility."

"Venture capitalists have strip-mined many great broadcast properties to make a fast buck. Anti-trafficking rules should be reinstated."

"We need to come to grips with the state-licensing issue. Help! Make the FCC recognize SBE certification."

"Low pay, long hours, little respect."

"Lack of respect from management is only the beginning. When combined with starvation wages, there is little reason to stay."

"I have to work at two stations just to equal the salary I was paid at one station a couple of years back."

"We're watching the end of broadcast engineering as we know it. It's been brought about by the bean counters."

"Automation is putting a lot of operators out of work."

"If you're willing to show some initiative, a multitude of opportunities will open up before you."

"We've had no raises in two years. I can't put up with this much longer."

"Wonderful opportunity in TV for computer person."

"There are plenty of opportunities in broadcasting — it's just being in the right place with the right experience."

"The reasons to listen to radio have changed. Stations program for diary keepers. The audience goes for 'What will I win?' "

"Engineers are not enchanted with a broadcasting job any more. It's just another job to them. The magic is slipping away to automation."

Selling management on AM stereo

By John P. Bisset

If your goal is AM stereo conversion, take a few tips from the sales staff.

As engineers, few of us would consider ourselves salespeople. But, like it or not, an important part of the job is selling. Take the chief engineer who wanted to supplement his income by selling spots. When he approached the general manager with the idea, the manager scoffed, "What do you know about selling?" The engineer replied, "Plenty ... I've been selling you for years!"

Before you say you can't sell, consider all the subtle selling techniques you've used over the years — techniques that got you the new console, the last set of tubes for the transmitter, maybe even your present job. Selling is important in engineering, especially when a major purchase is involved. This article will present concepts that you can use to sell management on AM stereo. Many of these ideas can be used for persuading management to make other major purchases as well.

Plan your strategy

Conversion to AM stereo may not be as costly as a new transmitter, but it still involves an investment. And, as with any cash outlay, a return on the investment must be demonstrated to upper management. Showing management that your proposal will solve a problem and serve a need is perhaps the most important tenet of selling. Besides, these are areas most managers understand — they've been selling your station to clients by creating solutions and meeting their needs for years. By developing a proposal that touches on these issues, you can be seen as a valuable team player, not just someone who wants to spend money. The proposal must present your idea in a way that shows it to be more than "just another toy or gadget for engineering."

Bisset is broadcast product sales manager for Delta Electronics, Alexandria, VA.

In preparing your recommendation, consider the various areas of improvement that will be realized through conversion to AM stereo. Because these are upgrades the manager can relate to, they should be an integral part of your proposal.

The first area of improvement is audience. With proper promotion, converting to AM stereo should increase the station's listenership. The large number of AM stereo car radios gives stations the ability to reach drive-time listeners by broadcasting in stereo and offering a higher-quality signal than their "mono" counterparts. The fact that the highest spot rates occur in drive time further supports this assertion.

Competition also must be considered. Conversion to AM stereo offers the AM station the chance to compete with FM. Listeners have been conditioned not to expect much from AM. But listeners, as well as the station staff, usually are pleasantly surprised at how good AM can sound on the new radios. The impact is made even more dramatic as more of the major-market FMs trash their signals in an attempt to be louder.

As an engineer, you may criticize the response of radios of certain brands, but studies by the manufacturers have shown the average listener is not aware of such nuances. Furthermore, a survey of more than 1,000 people, conducted last year by Strategic Radio Research of Chicago, found that nearly one-third of the listeners aware of an AM stereo station perceived that the broadcast sounded better in stereo.

Quality improvement also has been recognized as stations convert to meet the FCC-mandated NRSC-2 standard. As the station improves its transmitting efficiency by eliminating useless out-of-band signals, management becomes aware of the good-sounding signal its AM station can transmit. The surge in AM stereo orders since NRSC adoption shows the thinking to be something like, "If NRSC makes this much difference, AM stereo may be a sound investment after all."

Improvements heard after stereo conversion are not imagined, and they extend to the monaural signal as well. Conversion to AM stereo involves adjustments to the transmitter that reduce incidental phase modulation, or IPM. High levels of transmitter-induced phase modulation can result in a "muddy" or "blurred" monaural

Continued on page 52

Everything you always wanted in a tube camera. Except tubes.

LDK 910 CCD Studio Camera

What you've always wanted in a tube camera is the best picture possible. But now you get the best picture in a CCD Camera — the new BTS LDK 910. And you'll never miss the tubes. Because the LDK 910 meets or beats the picture quality of tube cameras with a new CCD sensor that employs over 800 pixels per line, and over 406,000 total picture elements.

LDK 91 CCD Portable Camera

In addition to excellent resolution, the LDK 910 has a high signal-to-noise ratio, high sensitivity and accurate colorimetry. Along with a few other things you don't get with tubes. Such as BTS's frame-transfer technology, which eliminates smear. A high dynamic contrast range without blooming or burn-in. And excellent dynamic resolution enhanced by advanced electronic shutter control. It's also ready to shoot when you are — no waiting for warm up.

And here's another reason you won't miss the missing tubes. Not only is the LDK 910 priced competitively with tube cameras, but it costs less than you'd probably spend replacing worn out tubes over the life of a studio camera.

But of course, big ideas also come in small packages. The LDK 91, a lightweight, easy-to-handle ENG/EFP camera, is the LDK 910's portable companion. Singled out by *Broadcast Engineering* magazine as one of the ten "Pick Hits" of NAB '89, it has the same CCD sensor and the same top picture quality as the LDK 910.

Together, these fully compatible CCD cameras will make your old ideas about picture quality go right down the tubes. For complete information and technical specifications on the new LDK 910 and LDK 91, call BTS at **1 800-562-1136, ext. 11.**

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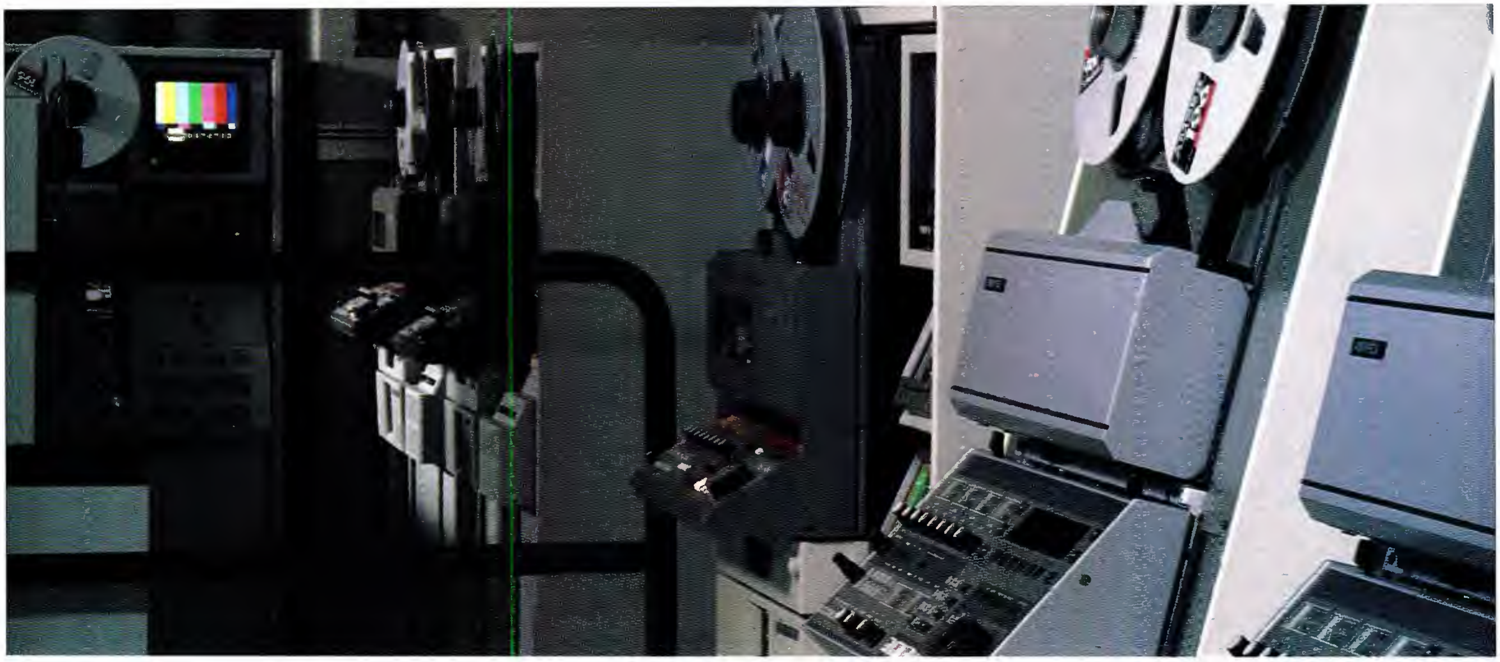


A convincing argument for Type C from a company that invented D2.

We didn't spend five years pioneering the world's first D2 composite digital recorder just to win technology awards—selling D2 machines is one of our top priorities.

But another and even more important priority for us is to make sure that the video professionals we serve have appropriate equipment for their jobs. And that they continue to look to Ampex for the straight story about that equipment and its applications.

"...business more than tripled this year using Type C..."

Bill Stokes,
Bill Stokes Associates

Ampex Zeus Advanced Video Processor

A case in point is the question we recently asked several of our customers who purchased Type C *after* we introduced D2.

"With the introduction of D2, why did you purchase Type C?"

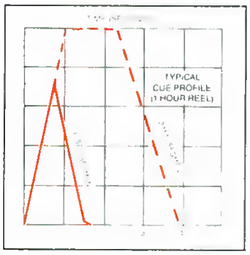
We think the answers we got may interest you if you're considering the purchase of *any* video machine.

Bill Stokes (*Bill Stokes Associates* in Dallas), came right to the point. "My business has more than tripled this year, and I'm using Ampex Type C machines. Is there any better reason to buy more? With the new TBC-7 or the Zeus processor they make perfect pictures. Besides, I like the service I get from Ampex."

Jerry McKinzie with *Cycle-Sat Communications Network* in Forest City, Iowa, (a satellite courier,

The VPR-80's Automatic Scan Tracking head and its erase head are both easily removed and replaced with only a screwdriver.

production, and post-production business), thinks it's important to be able to update easily as his business changes. "The hardware and software upgrades Ampex makes in their equipment allow me to keep my facility current, and to always give my customers the newest look. I like that, and my customers demand it."



The VPR-3's incomparable acceleration allows a 30 second segment to be re-cued and synchronously played in 2 seconds, using one hour reels.

Darrell Anderson, whose company *Anderson Video* in Los Angeles, recently purchased several

"... Type C business is readily available..."

Darrell Anderson, *Anderson Video*

VPR-3s, pointed out that the Zeus port allows interface with D2. Darrell believes that, "Type C and D2 will co-exist successfully in a well-managed facility. Type C business is readily available." We were gratified to hear that he, "bought the best Type C machine he could find."

Consider your purchase decision carefully. When the excitement of a new equipment introduction passes, and you've put the pros and cons down on paper, Type C may be exactly the right machine for your application. After all, it's still the world's broadcast interchange and distribution standard.

"... hardware and software upgrades keep my facility current..."

Jerry McKinzie, *Cycle-Sat Communications Network*

And it is obviously the perfect choice for facilities that are moving up from ¾-inch.

We'd like to be involved in your decision-making process, and we're as close as your telephone. Call Ampex at **1-800-25AMPEX** for some real help with a difficult decision.

AMPEX

BE-109-TYPC

Continued from page 48
sound image. After IPM is reduced, a clearer, better-defined monaural signal is noticed.

As you prepare your proposal, consider ways that AM stereo conversion would assist other staff members and departments. You'll have little difficulty getting the air staff and the program director on your side. But the conversion will affect other departments as well. A sharp sales manager will realize the advantages of AM stereo over other competing monaural AMs. If car dealers are among your advertisers, show them the list of in-car AM stereo radios. Each dealer is a potential sale.

Target Tuning's fixed-frequency C-QUAM AM stereo portable radio.

The same is true for the after-sale market. If your station has a full-time promotions director, discuss the promotion possibilities. The list is endless: stereo remotes from car dealerships, news coverage in the local newspaper as well as on local television, and many other awareness campaigns. For example, if your market has cable, you may be able to offer your stereo signal to the cable company in exchange for mentions. AM stereo stations can be placed alongside the FMs on the cable converters, or perhaps your stereo sound can be used as background music on one of the cable company's information channels.

In each case, your station will be seen as a leader, especially if you're the first in the market to go stereo. Discuss these possibilities with your fellow department heads. Help them to see that AM stereo is now and that it is something you should be a part of.

Justifying the cost

As you prepare your proposal, also prepare for the inevitable objections it will raise. The first, and by far the most popular, objection probably will be cost. Some managers think conversion to AM stereo is no less than a $150,000 investment. This misconception has been fueled by misinformation. Conversion costs are going to vary from station to station, but here is where the creativity of the engineer is put to the test.

Over the years, as equipment has failed, has it been replaced with stereo equipment or equipment that provided for later field-conversion to stereo? Keep this in mind as you upgrade studio equipment. Although a $150,000 figure may be realistic if complete studio conversions and new transmitters are required, the ability to change cart machine heads or unstrap the stereo console would make the true conversion cost more reasonable.

Specifying the ability to convert to stereo generally adds little to the price of new equipment, yet provides the engineer with the flexibility that will eliminate the higher replacement cost later. Is a new transmitter necessary? Usually, it's not. Certainly a new transmitter would be nice, but if the budget doesn't permit such a move, excellent results can be obtained using the older plate-modulated rigs with minor modifications performed by the installation technician. Some of the best separation figures installers have seen have been on transmitters that appeared ready for the scrap heap.

The total conversion price also will be dependent on your format. For stations using satellite-delivered programming, the conversion cost could be just the stereo exciter, monitor and processor. Although the station's production still would be monaural, if budget is a concern, the commercials don't have to be in stereo. For the smaller-market station using satellite-delivered programming, AM stereo comes well within reach.

Providing the manager with several cost-saving options can help you overcome the price objections. You may want to price the total system to include new studio gear, propose another price to show retrofitting existing equipment and a third price for the "bare-bones" approach. Be sure to have a list of benefits and drawbacks for each option.

As you prepare your pricing breakdown, don't overlook the possibility of leasing the new equipment. Although some of the tax advantages of leasing have changed, management may find it more appealing to think in terms of the smaller monthly payments that would be possible through a lease plan.

Breaking down the investment in AM stereo is akin to breaking down the price of transmitter tubes. The initial purchase price for tubes seems high, but when you divide the number of hours of service by the total cost, it seems quite reasonable. An interesting question to pose to your manager might be, "Would you like to grab more drive-time listeners and compete with the FMs for only $3.40 a day?" Divide the total cost of the equipment ($12,500) by the number of years of useful service (10), then divide by 365 days to offer your manager this more palatable figure. Apply your spot rate to the pricing figure to show even more dramatic results.

Another common misconception, and one that could be used as an objection by your manager is, "There are no radios." This simply is not true. Nearly every auto manufacturer offers AM stereo radios; in many cases, they come standard with the car. In at least one case, Chrysler/Plymouth products no longer offer mono AM radios. More than 1.5 million of these cars were sold last year.

If the manager complains of the lack of portable radios, tell about the new low-power radio chip developed by Motorola. This AM stereo "radio on a chip" is now in production, and it should make low-cost portables a reality. Meanwhile, at least one company (Target Tuning of Moonachie, NJ) has used a similar low-power Motorola chip to provide a portable AM stereo radio with a different twist. Like its FM counterparts, this radio has a plastic case that can be silk-screened with the station logo on one side and a sponsor name on the other. The sponsor picks up the cost of the radios as part of the promotion.

Such promotional trade-outs cost the

AUTOMOBILES WITH C-QUAM* AM STEREO RADIOS

- ACURA
- AUDI
- BUICK
- CADILLAC
- CHEVROLET
- CHRYSLER
- DELCO/GENERAL MOTORS
- DODGE
- EAGLE/JEEP
- FORD
- LINCOLN
- MAZDA
- MERCEDES
- MERCURY
- MITSUBISHI
- NISSAN
- OLDSMOBILE
- PLYMOUTH
- PONTIAC
- ROLLS ROYCE
- SAAB
- TOYOTA
- VOLKSWAGEN
- VOLVO

SONY
BCT-20M

station nothing, yet they net tremendous promotional returns. Also, the radios help erase the stigma of poor quality that is associated with AM. Listeners at a remote, for example, are given these fixed-tuned stereo radios. No mention is made of AM. They hear your station, and your station alone, in stereo. There is no AM-FM selector and no tuning dial. Promotional radios of this type work wonders in converting the younger generation, which has grown up on FM, to the alternative of AM stereo.

More hope is on the way with respect to the portable radio issue — a decision from Japan on an AM stereo standard is forthcoming. This should signal the beginning of more AM stereo portable radios as Japan joins Canada, Brazil and Australia in adopting a standard.

The bottom line

There is no question that capital equipment purchases have gotten more difficult over the years. Debt service, budgets and sales quotas all are tugging at the general manager. If you do sufficient research on your proposal and provide the information to your manager along with your purchase order, your chances of approval are improved. It is important that you believe in your proposal. Although the conversion to stereo will mean a quality improvement, you must look beyond the obvious to determine the additional features such an investment would provide.

By selling your proposal as an investment, you are looking ahead to the future of the station. It shows the progressive manager that you are not content to rest on your laurels and collect a paycheck. You are an integral part of the management team.

AM STEREO CAR RADIOS
(After-Sale Market)

AUDIOVOX
BLAUPUNKT
CLARION
EUROVOX
KRACO
MARANTZ
PHILIPS
RADIO SHACK
SHERWOOD
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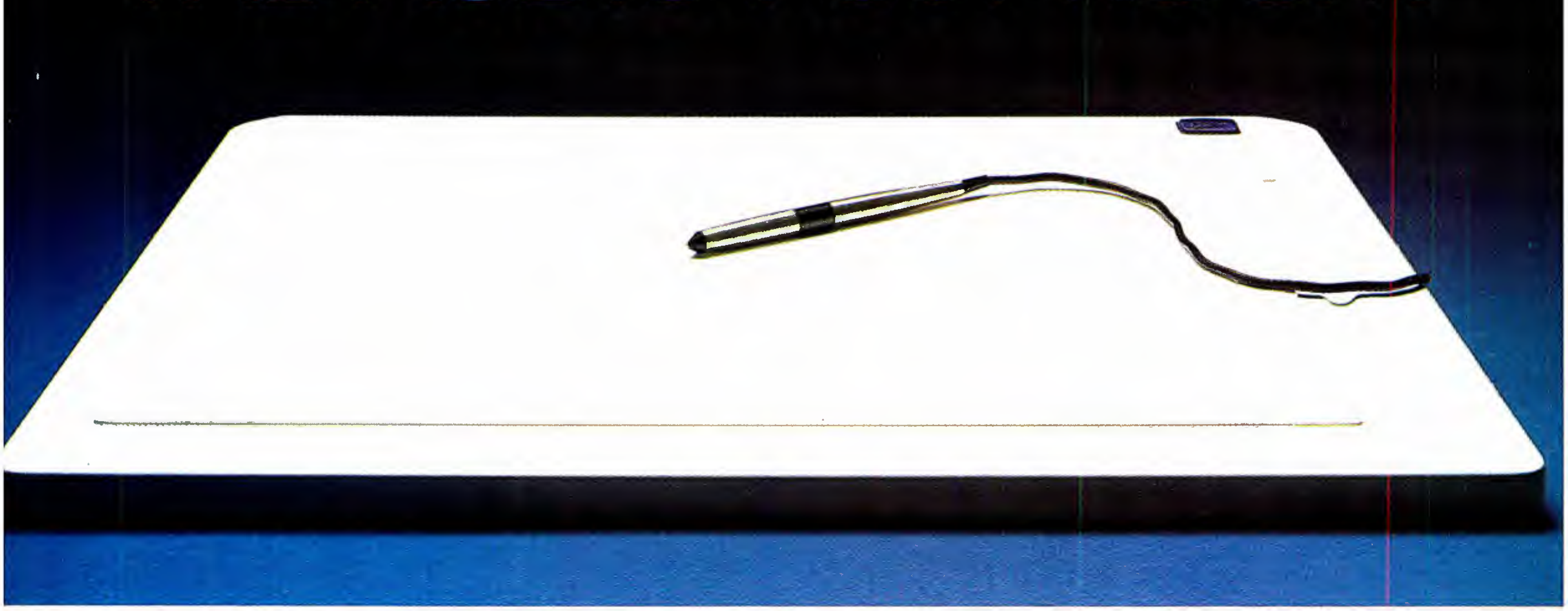
THE AUDIO POST ROOM



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ScreenSound provides the first working environment built around the editor, not the equipment, leaving him free to use his creative skills on the final soundtrack.

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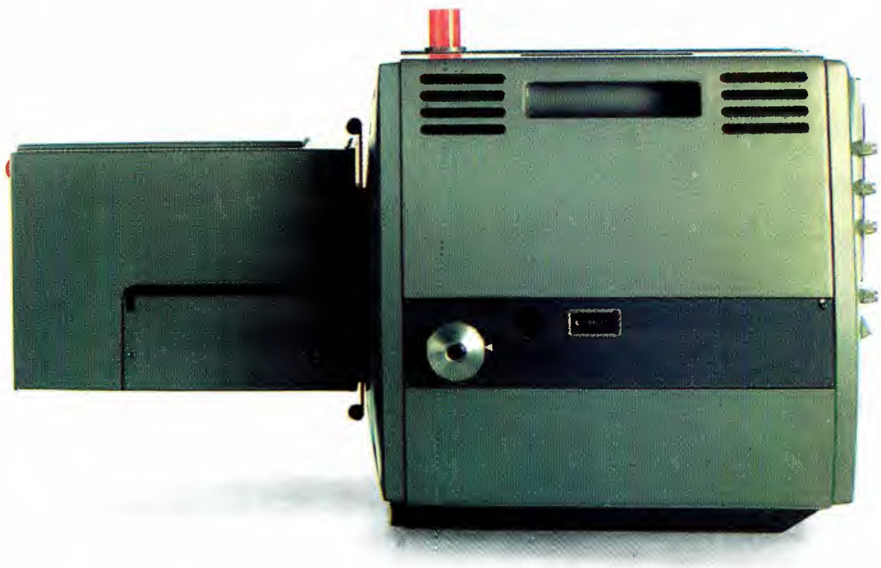

Plumbicon Tube Camera

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switchers, videotape recorders and graphics equipment are among the best-engineered, highest quality and most reliable in the world. Our work in High Definition and CCD products is pacing an industry which faces the most sweeping technological advances since its beginning.

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AM stereo: Its time has come

By Ronald F. Balonis

Technology is only part of the solution to AM radio's future.

Have you ever asked yourself why every radio made today doesn't contain both AM and FM stereo decoders? Why every AM station in the United States hasn't adapted to AM stereo broadcasting? Or why, after almost 15 years, the AM broadcast and receiver industries have not produced a compatible transmission and reception system for the American public?

The same type of technology that has made FM stereo popular today can do the same thing for AM stereo. Over the past 20 years or so, much research has been done on the theoretical principles and applications for AM stereo. Experimental designs have been tried and tested, and several systems have been marketed. The main point to remember is that compatible AM stereo *is* technically feasible. It's not a case of approximately 400 million monophonic AM radios suddenly becoming obsolete.

Unfortunately, the reality is that AM stereo is only a technical innovation. Like other broadcasting technical innovations, AM stereo has matured from a technically infeasible concept to a marketplace reality. Even though the marketplace has not exerted the energy to make AM stereo a driving force, AM stereo is a technical innovation whose time has come.

Some history

The history of radio broadcasting is a chronology of technology and innovation.

Balonis is chief engineer at WILK-AM, Wilkes-Barre, PA.

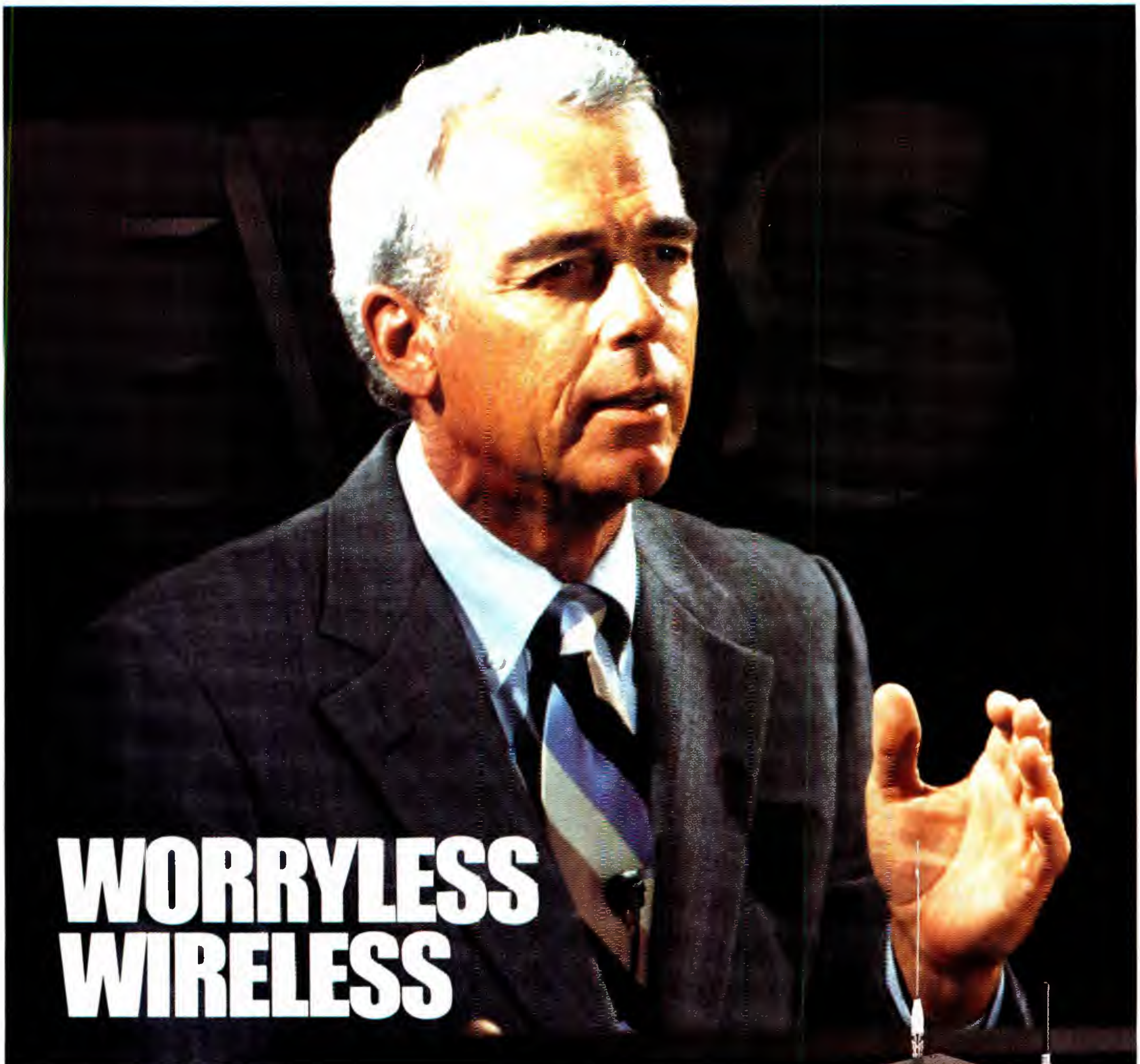
The birth of radio broadcasting was sparked by the efforts of creative experimenters and inventive tinkerers — technical types. Radio was nurtured by visionary entrepreneurs, then stimulated by society's needs. The story of radio is a story of technological innovation, of technological push and market pull.

It all started more than 300 years ago, with an idea that there was something there. Here's how radio evolved:

- *1678:* Christian Huygens theorized that light was caused by the rapid vibration of invisible waves.
- *1750:* Ben Franklin knew something was out there. He was struck by it.
- *1832:* Michael Faraday theorized that the electricity in magnetism was sent through space by some sort of vibrations.
- *1873:* James Clerk-Maxwell formulated a theory of electricity and magnetism — electromagnetic waves.
- *1883:* Thomas Edison invented the electric light and discovered the "Edison effect," electron flow in a vacuum.
- *1888:* Heinrich Hertz proved the existence of Clerk-Maxwell's electromagnetic (radio) waves.
- *1896:* Marconi put the electromagnetic theories of Clerk-Maxwell and Hertz into practice by discovering wireless communication.
- *1904:* Ambrose Fleming applied the Edison effect to invent the vacuum diode tube.
- *1906:* H. H. Dunwoody and G. W. Pickard discovered a solid-state semiconductor, the crystal detector.
- *1906:* Lee De Forest invented the triode vacuum tube.
- *1912:* Edwin Armstrong discovered regeneration (the positive feedback circuit).
- *1915:* Irvin Langmuir discovered that improving the vacuum made electron tubes function better.
- *1918:* Edwin Armstrong discovered the superheterodyne circuit.
- *1919:* The Radio Corporation of America was formed by GE and AT&T. David Sarnoff conceived the idea of a radio as a home utility.
- *1920:* KDKA and WWJ began broadcasting.
- *1924:* RCA marketed an easy-to-use 6-tube superheterodyne radio.
- *1926:* Radio becomes a home utility, and dawn breaks on the "Golden Age of Radio."

The development of the electronic vacuum tube was the technical innovation that signaled the beginning of radio broadcasting. The first broadcast technical innovation was the transmission and reception of amplitude modulation (AM).

In 1933 Edwin H. Armstrong, in search of improved transmission methods, discovered frequency modulation (FM). In 1945, after many years of experimental work, FM became radio's second technical inno-



Your mic is the last thing you should have to worry about when you are on the air.

Telex understands the broadcast and video production industry. After all we've been a leading manufacturer of broadcast quality microphones, intercoms and headsets for over fifty years. And, recently our wireless systems have become first choice among those who can't afford to have their mics fail. When you clip on a Telex—don't worry.

We know that, in the serious business of television news, when the story is unfolding you've only got one shot at it. And, in production, when you make expensive talent wait for a new mic—you've just lost money.

Telex wireless microphone systems have been designed to stand up to the rigors of difficult remote ENG assignments as well as the daily abuse of studio and location work.

Shown above is our frequency selectable series featuring the FMR-4 rack mount receiver, ENG-4 portable receiver, HT-400 hand-held transmitter/mic and WT-400 beltpack transmitter with lapel mic. For more information call or write to: Telex Communications, Inc., 9600 Aldrich Av. So., Minneapolis, MN 55420.

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vation. Finally, the development of electronic solid-state technology, transistors and ICs made FM stereo a marketplace reality.

And so it went, with technical discoveries, inventions and innovations feeding on each other, one after another. The changes, new techniques and improvements came faster. The result was better reception, higher-quality transmission and expanded use of the medium.

Stereo appears

The idea of stereo goes back to the middle of the last century, almost to the beginning of broadcasting. However, it takes more than just an idea to make a technical innovation. The technology to implement it was simply not yet developed.

In 1925, WPAJ, New Haven, CT, made one of the first experimental stereophonic broadcasts. The broadcast relied on two microphones seven feet apart and connected to two transmitters. One transmitter operated on 227m (1,321kHz) and one on 270m (1,111kHz).

The tests worked well for headphone listening. Unfortunately, if loudspeakers were used, the effect was less startling because the channels became confused. As expected, the system produced acceptable monaural compatibility. Over the years, stereo experiments continued, and as technology improved, better stereo broadcasting became feasible. Interest in stereo also increased.

In the 1950s, many experimental stereo broadcasts relied on both AM and FM transmission. One channel was carried on the AM station and one on the FM channel. Other combinations also were tried: FM-FM and even FM and television. With the introduction of stereo discs in 1958, the pressure for effective stereo broadcasting methods increased. Now the marketplace began to influence the broadcast industry.

Sequential process

FM radio had become reality just before World War II. Significant advancements had to wait for more peaceful times. FM stereo developed in a somewhat more orderly and regulated way. Prodded by the technical success of the stereo LP, the National Stereophonic Radio Committee (NSRC) was established under the sponsorship of the Electronic Industries Association (EIA). It was a driving force for FM stereo.

The committee's purpose was to make detailed studies of the methods for providing compatible stereo sound for AM, FM and television. The NSRC report was presented to the Federal Communications Commission in early 1960. After a year of study and consideration by the FCC, it issued the FM stereo rulemaking selecting the Zenith-GE FM stereo system as the standard. Radio broadcasting's third technical innovation had become a reality.

The concept was a little ahead of its time in regard to making the system work. Stereo FM began slowly because it depended on the electronic tube for its implementation. The transistor and integrated circuits helped solve those problems. In less than 10 years, the required technology caught up. The rest is history.

AM stereo arrives

The technology necessary to make broadcasting's fourth technical innovation (AM stereo) a marketplace reality has been around for more than 20 years. However, its pathway has been tortuous and difficult.

AM stereo is an old idea, and the same technology that produced FM stereo also is available for AM stereo. Partially in response to the success of FM stereo, the National AM Stereophonic Radio Committee (NAMSRC) was formed Sept. 24, 1975, to study AM stereophonic broadcast systems.

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It was jointly sponsored by the EIA, NAB, NRBA (National Radio Broadcasters Association) and the BCCE (Broadcasting, Cable and Consumer Electronics Society of the Institute of Electrical and Electronics Engineers).

The objective of the committee, like the NSRC of two decades earlier, was to evaluate and draw technical conclusions regarding AM stereo transmission. The committee was to report the results to the FCC, which then would act.

On June 22, 1977, the commission adopted a Notice of Inquiry for AM stereophonic broadcasting. On Dec. 19, 1977, the committee issued its report. After four months of consideration, the FCC voted on April 9, 1978, to allow AM radio stations to broadcast in stereo. The commission selected the Magnavox AM stereo system. This should have marked the beginning of radio's fourth technical innovation, AM stereo. Unfortunately, that was not the case.

The battle ensues

In reply to its ruling, the FCC received a flood of objections. It seemed that few were interested in that system. The commission decided to rethink the original selection. This time, a system of quantitative analytical assessments was used to evaluate each of the systems.

Consequently, a Memorandum Opinion and Order and further Notice of Proposed Rulemaking was issued on Sept. 11, 1980. This produced 23 formal comments and 17 replies from interested parties. In these, the commission noted that "no new matters of significance were raised." The FCC then assigned two senior engineers to study the matter.

After five months of study, the conclusion was that comparative data on the systems was incompatible and not comparable. Many factors were subject to engineering judgments. The conclusion was that any decision would be highly tenuous and that the results were so close there was no clear choice. In a sort of déjá vu, a threatening litigious cloud settled over the AM stereo decision.

Decide to not decide

On March 4, 1982, the FCC issued its now-famous AM stereo free-marketplace ruling. After seven years, that's where AM stereo still is — waiting for the marketplace to decide.

For AM stereo, the creative and inventive innovators have been at work providing lots of technological push. However, the pushing is in too many different directions. The result is that today's marketplace is stretched too thin to sustain the innovation.

We've lived with monaural AM for more than 50 years because mono was all that was technologically feasible. That is no longer the case. There are few technical impediments to AM stereo at any station. The technology can be implemented with a moderate amount of technical expertise and a relatively small amount of capital. Despite how it's been marketed or the promises made or the beliefs held, AM stereo's time has come.

(See related article on page 64)

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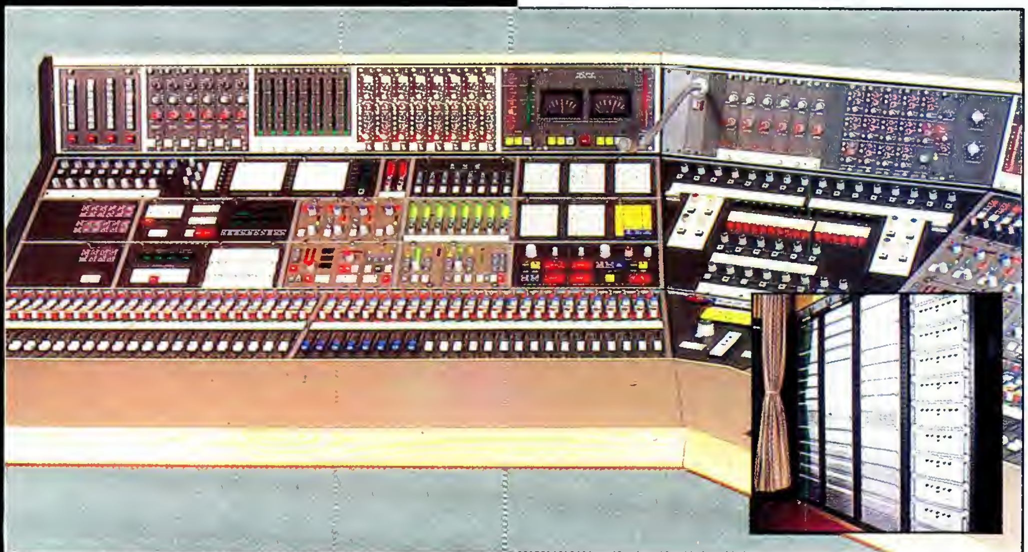

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Technical innovation vs. the marketplace

Although the pace of AM stereo, broadcasting's fourth technical innovation, seems to be slower than that of the others, it actually may not be. It took six years of improvements in electronic technologies before AM radio could break into the marketplace. It took about 12 years for FM radio to become a commercial reality. Another 10 years passed before it became a self-sustaining market.

Four things are true of each of broadcasting's technical innovations:

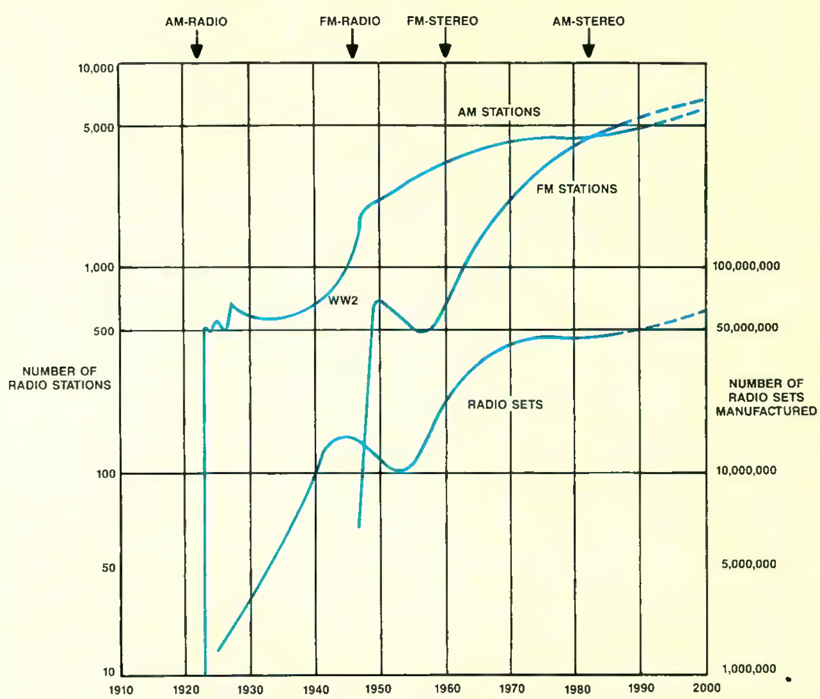
- The idea or concept preceded the capability of technology for implementation.
- The transmit side preceded the actual reception by the marketplace.
- Technical difficulties and market resistance had to be overcome.
- It took time for implementation and acceptance.

AM stereo

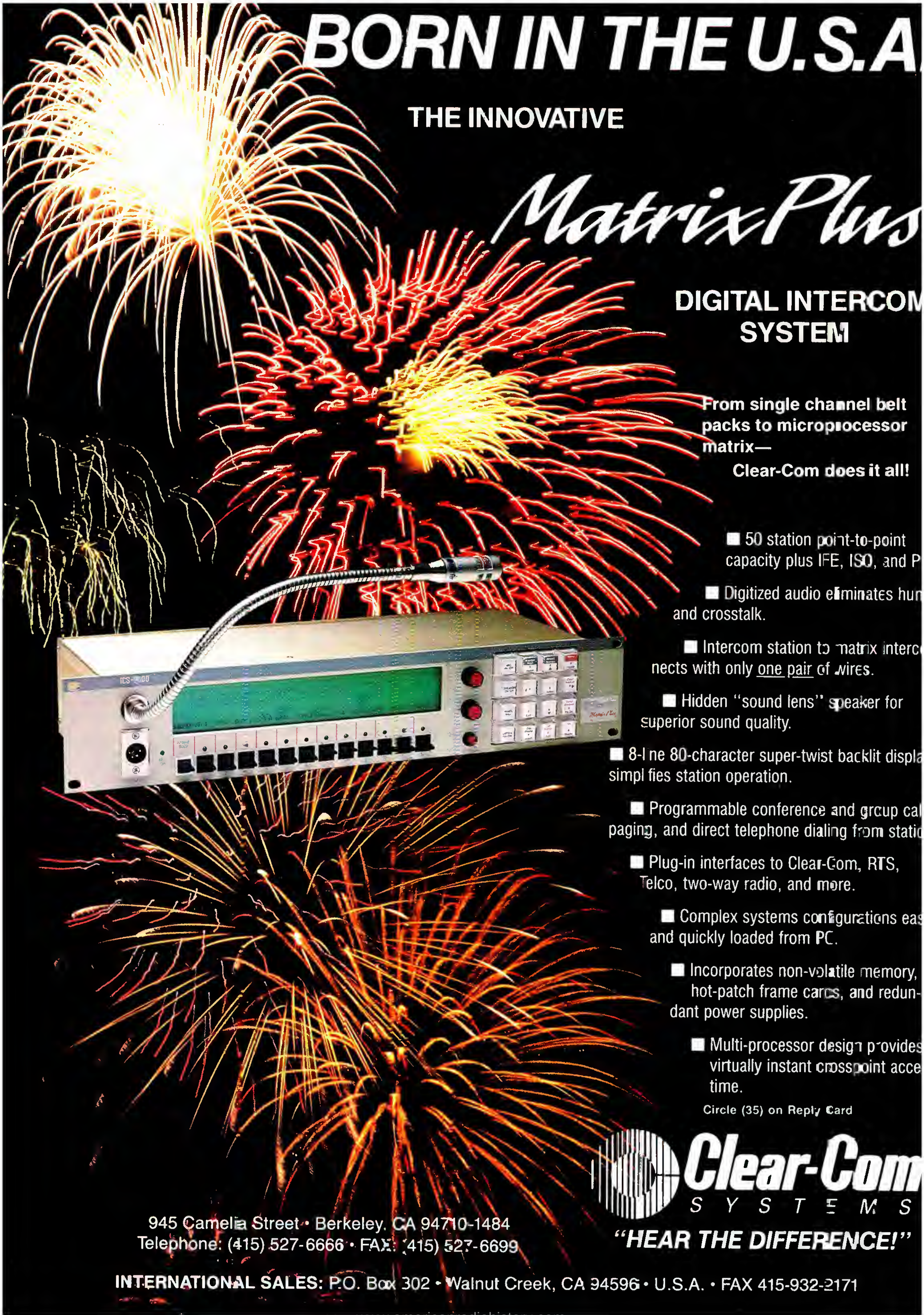
If the decision to implement AM stereo by stations and receiver manufacturers was a purely technical one, it would already be a marketplace reality. However, the decision is not purely technical. Technology doesn't exist in a vacuum.

Technology is a part of our cultural, social and economic systems. Each of these areas sometimes pulls technical innovations in opposing directions. In a competitive, deregulated marketplace there is little to favor technological altruism. Instead, the calculation of expected returns on investment, costs and benefits are the major (sometimes the only) determinants for the direction taken by technological innovation. This is true for AM stereo.

We now have a stalemate. This dilemma can be broken only from within. It's time for AM stations to make the push toward AM stereo. If they don't, the marketplace may see little reason to adopt the readily available technology.



The meteoric rise in radio's popularity reached a plateau in about 1970. Future growth depends on both technical innovation and marketplace desires.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Audio fidelity: the grand illusion

By Dennis R. Ciapura

A better understanding of audio perception may one day lead to a sonic product that is more a function of design than chance.

Since the first sounds emanated from the primitive speakers of the earliest radio receivers, broadcast engineers have sought to achieve accurate reproduction of the program source in the firm belief that this was actually an achievable undertaking. After all, it certainly seemed reasonable to assume that there would eventually be sufficiently perfect microphones, transmitters, receivers and speakers to make perfect fidelity a reality. This simplistic dream of a logical path to audio karma was born of the altogether plausible concept that microphones could be made to hear like ears and that speakers could be made to radiate this perfect analog without audible alteration.

Mission impossible?

After nearly a century of working the problem, we have acquired enough knowledge to begin to understand how naive we have been. There is much evidence to suggest that it may never be possible to devise microphones that hear like the ear, or speakers with the required radiation properties. The reason is that the role of the brain in the ear-brain system is much more complex than anyone would have guessed just a decade ago. We are in our wonderland, a bit like Alice in hers, finding things "curiouser and curiouser."

The role of the brain is not limited to simple real-time processing of auditory input, but of perceptions based on continuous analysis of the acoustical environment. Unfortunately, the complete original sound field, not just a sampled pressure wave, must be reproduced entirely intact for the ear-brain system to function properly. This is an immense undertaking in electro-acoustical terms.

Ciapura is vice president of technical operations for Noble Broadcast Group and president of TEKNIMAX Telecommunications, a San Diego-based technical management consulting company.

Testing the hypothesis

If you have your doubts, there is an easy demonstration that illustrates the point. Set up either a mono or stereo microphone position on one end of a fairly large room, and feed the output to an audio system with excellent fidelity located in another room. Now stand near the position of the microphones, and have someone speak to you from across the room. After listening to the live speech for a while, go to the monitoring room and listen to the electro-acoustical reproduction. You will undoubtedly find the reverberant content and spectral balance to be much different.

This still will be the case if headphones are substituted for speakers, regardless of the microphones used. The only thing that will change is the degree and character of difference. For anyone with any professional audio experience at all, this need only be a mental exercise. Experience dictates that the person speaking will need to be quite close to the microphone. Considerable attention must be paid to microphone selection, positioning and, possibly, equalization to achieve realistic reproduction, even though the fidelity of the microphone and everything else in the chain far exceeds what should be required for voice reproduction.

It is interesting that cardioid or hypercardioid pattern microphones generally produce the best results in picking up distant sources, but human hearing is basically omnidirectional. So why is it that you could walk into that same room, stand all the way at the far end and hear the live speech so naturally with your omnidirectional hearing? Ear-brain processing results in the astounding ability to differentiate the sound of an audio source from the characteristic sound of the acoustical environment into which the source radiates. Unfortunately, the mechanisms that allow the ear-brain system to accomplish this incredible task need the complete original sound field, not just parts of it.

Hollywood's audio engineers have long recognized this dilemma, and since the earliest days of sound on film, they have used looping and Foley techniques in place of location audio when speech is unintelligible or sound effects from the field are unrealistic. In fact, in a major movie production, less than 50% of the location dialogue may be used, with the rest being looped by the actors in post-production. Similarly, every footstep and door closure is likely to have been recorded on the Foley stage with a microphone in close proximity to the source. In effect, the screen becomes a voice, not an ear.

Can binaural recording achieve realism?

If it is so difficult to bring a clone of the original sound field to the listener's ears, why not take the ears to the source? Over the years, binaural and binaural synthesis recordings intended for headphone listening have been made with special microphones in dummy heads. The process has achieved some success, but even this highly restrictive methodology falls short

of absolute realism.

Part of the alteration is due to the destruction of the pinna conch cavity resonance in the acoustical path from the headphones to the eardrum. Although attempts have been made to electrically equalize the headphone output to simulate the conch resonance, the naturally occurring resonance has directional characteristics, so any equalization is necessarily a compromise. Headphone reproduction also limits the opportunity for low-frequency transmission via bone conduction — also a necessary element for total realism.

Transaural techniques allow binaural programming to produce good results with loudspeakers by planting an anti-crosstalk signal to cancel the acoustical blending between the speakers. Although this approach results in a greater impression of space and a more natural low-frequency feel than headphones provide, there is a limited zone in which the anti-crosstalk effect can be sustained, and so the listening environment is somewhat restrictive.

Although the various binaural and related systems provide intriguing simulations, for total fidelity we keep coming back to the basic requirement of reproducing the complete sound field. That means no interference from any other sound field and unaltered listener head absorptions and reflections, in addition to reasonably good electro-acoustical performance. We can fantasize about a microphone with a zero mass spherical diaphragm feeding a zero mass spherical diaphragm radiator, but even this extreme approach would be subject to the inevitable interference from standing waves inside the audio bubble.

Key concepts affecting broadcast audio

Of all the amazing capabilities of the ear-brain system, the ability to hear through the acoustical environment to the source is perhaps the most relevant to broadcast audio work, because it bears directly on how we engineer our monitoring systems. Audio perception expert Dr. Diana Deutsch confirms the validity of the phenomenon of the ear-brain system being able to hear through the acoustical environment. Deutsch reports that her research in related areas continues to disclose more and more evidence of the auditory perception system's ability to learn the surrounding acoustical environment and perform whatever psycho-acoustic processing is necessary to adapt to it. However, there has been no research directed specifically at learning more about exactly how it works.

Among the many examples of complex auditory adaptations involving tremendous processing in the brain are startling differences in perceived pitch, depending on the listener's individual requirements. Some percepts seem paradoxical at first because we don't understand the reasons for them, but in the end, most seem to serve some definite function related to enhancing the intelligibility of the raw acoustical input at the ear. In any case, one of the few things we know for sure is that even the best microphones don't hear like an ear.

Dr. Diana Deutsch and the author discuss audio perception in her lab at the University of California at San Diego.

Claims frequently are made touting the perfect fidelity of various systems and components, but when it comes to overall fidelity of reproduction, the only way to gauge the effectiveness of a given electro-acoustical chain is to listen to the source live, then immediately listen to the attempted clone. There is no way on earth to listen to an audio system and make a meaningful statement about the fidelity without comparing the output with the sound of the source while the sonic impression of the source is still fresh in mind.

Aside from gross anomalies, attempting to make judgments about the spectral balance, stereo imaging or instrumental voicing of an orchestral recording without ever having heard the original is ridiculous. Similarly, it would be fallacious to critique the fidelity of a system reproducing a rock recording without having just heard the final mix in the original control room. In either case, you may have a personal and subjective impression of the fidelity, but no objective judgment is possible.

John Gregory, renowned producer, composer and conductor in the United Kingdom, has spent a lifetime comparing live orchestral music with electronic reproduction. Winner of the prestigious Novello Award (the U.K. equivalent of the Grammy), Gregory has more than 30 years of experience standing in front of live performances and immediately listening to the recorded version in the control room.

In the early days, he listened to simple analog 2-tracks. Later, there were 16- and 24-track recordings, and now, of course, there is digital. With all the advances in recording technology, Gregory thinks that it's still more art than science and that the most audible improvements seem to be in the areas of noise reduction and control flexibility through ever-increasing track capability.

Gregory also believes that the major challenge today is the same as it ever was. Does he take the unique properties of the human hearing mechanism into account when recording? "Oh my God, yes," he said. "I write (music) for the microphone in the same way that I sometimes write to complement the characteristics of certain musicians. So much is going on, and everything interacts with everything else. When you listen to it live, the ear makes sense of it all without (your) having to think about it, but as soon as you pass it through microphones and out of speakers, it's not sound anymore, it's audio, if you know what I mean. It takes quite a lot of processing to make a good approximation of the original performance. You do the best you can."

Practical implications

Although the foregoing may be interesting, how does it apply to professional audio, and to broadcast operations in particular? In response to the conflict between the desire for realism and practical con-

Continued on page 74

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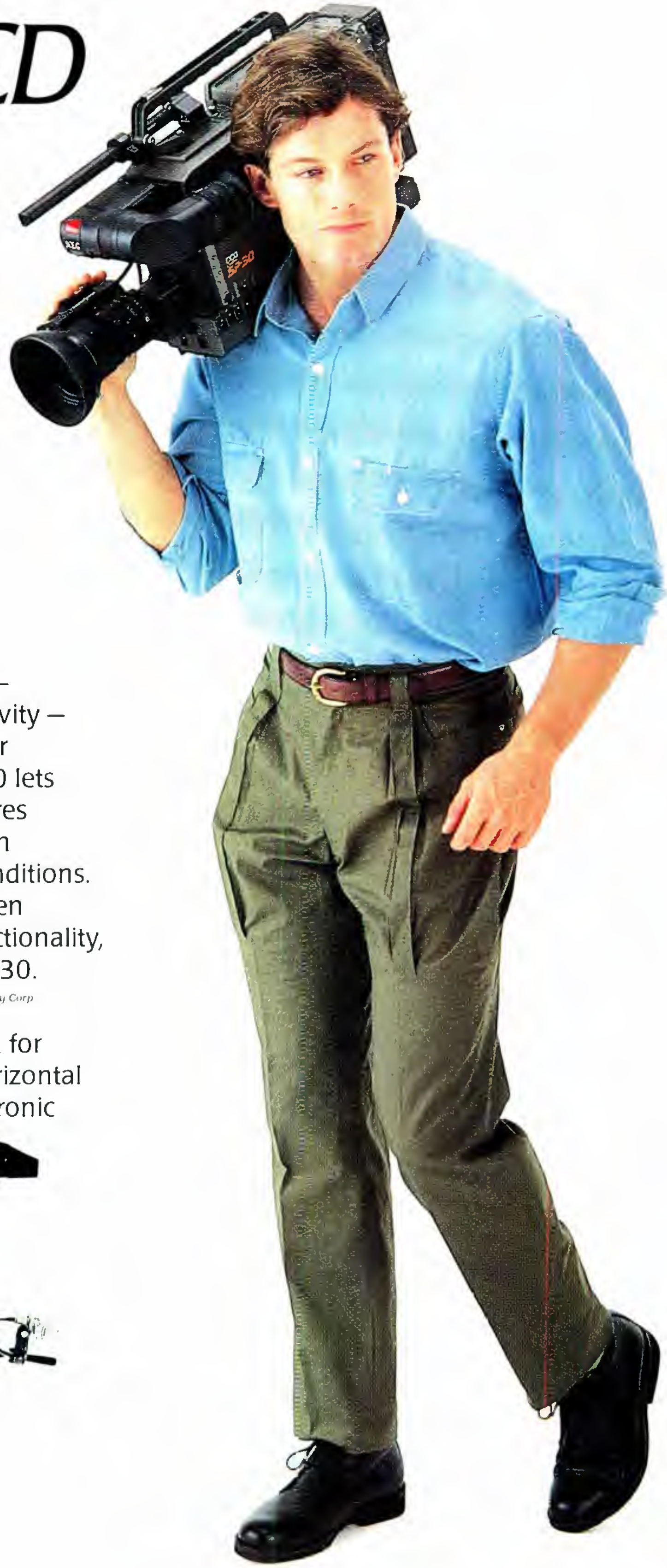

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Continued from page 70
siderations, audio professionals striving to accurately reproduce a source typically subscribe to an uneasy dichotomy of ideals: We strive for perfect electrical fidelity in recorders, audio-mixing equipment and transmitters. Meanwhile, however, we grossly reshape the audio characteristics with signal processing, on a largely empirical basis, to arrive at something reasonably close to the original performance. In fact, most of us feel a little guilty at times about all the processing and the fact that we know so little about why we have to do it.

When the mission is to create a sonic image with relatively little regard for realism, as is frequently the case with rock programming, we may lapse into our artist-with-audio-palette motif and feel less constrained in our processing, both in the production studio and in the program chain. This is different than the minimal processing approach typical of fine arts stations, but down the line, the product will be subject to the same limitations. They will simply manifest themselves in different ways. Instead of worrying about reproducing a studio or location sound field, we need to reproduce the field we generated in the control room with all the electronic toys.

In the case of rock recording artists on tour, an interesting reversal occurs: It is difficult to create a live performance that sounds like the one created in the control room! The audio people for most contemporary groups have opted for SPLs above the threshold of pain in vain attempts to compensate.

Given the state-of-the-art, it doesn't seem likely that there is any short-term solution to the dilemma of the ear-brain vs. electroacoustics. However, in terms of not making things worse, is there anything we *shouldn't* be doing? If you accept the concept of the ear-brain system being able to hear through the acoustical environment to the source, there are a number of fairly common audio practices that deserve review.

Control-room monitor EQ techniques are particularly suspect. If we hear through the control-room acoustics to the speakers, then the only electrical EQ that makes sense is close-field equalization of the speakers and nothing more. Any attempt to equalize room responses is likely to cause a perceived spectral distribution that is less accurate than doing nothing, because the ear-brain system will adapt to the raw room sound and hear the total electrical EQ as coming from the speakers. This is why initial attempts at "room" equalization often seem overdone, and second and, often, third iterations embodying less and less EQ are required to arrive at something that sounds subjectively correct.

Obviously, an erroneous monitor-system response characteristic in a production studio will result in erroneous EQ of the product generated there. In effect, the operators will be producing material that is what they intended it to be only when played in that room. If the control room, the engineering office, or the program director's or chief engineer's home system is "equalized to the room," incorrect transmission signal-processing decisions result.

Although many stations and producers intentionally attempt to differentiate their product with unusual processing, we occasionally encounter a recording or FM station that was intended to be flat but still has a strange spectral skew. That brings up the question of whether there's a monitoring system out there someplace that has quite the reverse curve!

Actual acoustical treatment of the room is quite another thing, and the current trend to live-end/dead-end (LEDE) treatment appears to be right on target. A reasonably neutral control room minimizes the need for the ear-brain system to generate corrective processing, and this probably results in reduced listener fatigue. Additional electrical EQ through the speakers may have the reverse effect. There are those rooms that we hate the sound of even though we've done everything possible to "EQ them flat."

With the concept of hearing "through the room" in mind, it is easier to understand how we often find new listening environments strange-sounding at first, but get used to them after a while. This same phenomenon also may be experienced by someone returning to work within a familiar acoustical environment after a vacation period. The adaptation process happens so subtly and effectively that it is best observed by removing the familiarity factor to experience the initial sonic impression. In fact, this is probably the best way to subjectively assess the acoustical properties of a room.

Does real stereo exist?

It is interesting to reconsider the validity of some common microphone techniques intended to bring the sound of the original performance space to the listener, particularly in live music remote broadcasts. It is tempting to think that a stereo pair suspended in a high frontal position will provide a true stereo field because the simplicity of the arrangement prevents a lot of potential microphone interactions and almost ensures a natural mix.

Unfortunately, the eventual loudspeaker output resulting from this simple but elegant technique will provide only an approximation of the original sound field. The output will certainly contain plenty of L–R that can be called stereo effects, and the localization of individual instruments and groups will be approximately correct as a function of relative L and R amplitude, but that's about as far as the fabled stereo "imaging" goes. Interestingly, if an ideal sound field reproducer were possible, only one radiator would be required to generate the stereo effect.

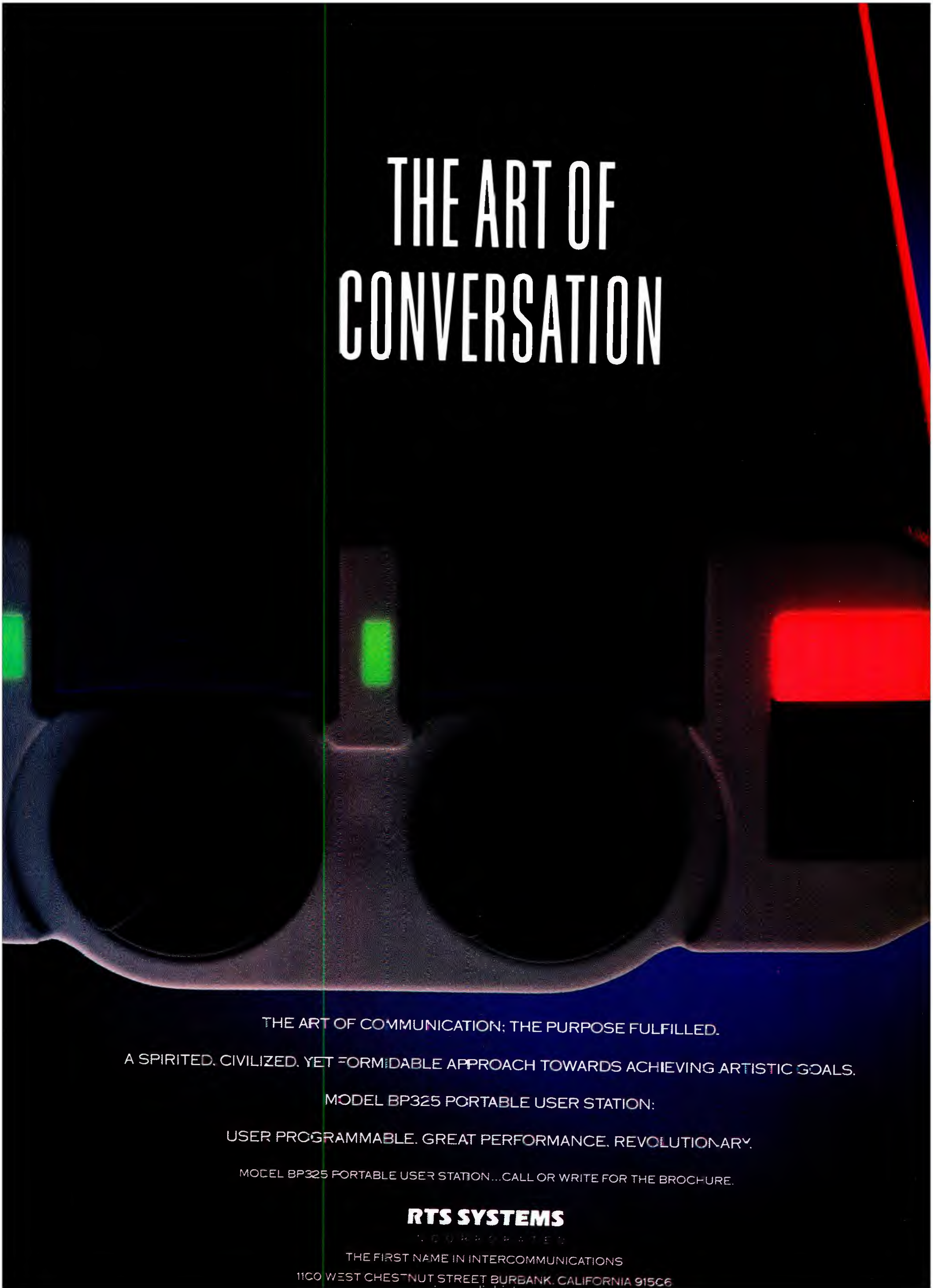
Trying to reproduce the sound of the concert hall itself is another pipe dream. It is probably no more intellectually honest to attempt to capture the sound of the original orchestra and hall than to assemble the same performance in the studio with multiple microphones and artificial reverberant effects. Therefore, it doesn't make much sense to compromise microphone technique in quest of some elusive stereo image or hall sound objective when setting up remote broadcasts of orchestral performances. The listener will be far better served by a comprehensively sampled, well-balanced mix with a panned stereo spread and a blend of either artificial or natural reverb. This is particularly true for TV audio, for which the mono absolutely must be right.

If we are really honest about what we're doing, we have to admit that there is probably no such thing as real stereo from electro-acoustical media. The best binaural attempts come closer than anything yet developed, but for the most part, the final sound field generated by any means is a simulation. Many may find this disconcerting because, at first blush, it seems to drive the purpose from our work to improve the audio state-of-the-art. The saving grace is the realization that the work is art as much as it is science, but improving the science helps us to better understand the limitations of the medium and improve the art.

Audio perception: another tool of the trade

Whether the objective is to reproduce a live performance, a control-room synthesis or, more likely, a combination of both, we must learn to use audio perception factors as tools of the trade. Just as we must keep abreast of the latest digital trends, we need to continue to improve our understanding of how people hear. It's an almost absurdly obvious statement to make, and yet the work of Diana Deutsch, Richard Warren, Roger Shepard and other pioneers in the field is not as well-known, understood and applied in studio practice as one would think, in view of its potential impact on the effectiveness of the audio product.

We dream of a day when some perfect source can be perfectly recorded and reproduced. It is unsettling to realize that, in spite of all the advances in audio reproduction, in the end we are like travelers who have crossed a vast expanse, only to peer over the crest of the final mountain to find another vastness beyond.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SCA technology update

By Phillip Kurz

If you only associate SCA with elevator music, listen again.

Suppose you are the FM station general manager faced with trying to improve the bottom line. What do you do when there is no fat left to trim from the operation, and you are completely sold out for the next six months?

In the past, you may have looked to SCA services for an answer. The process required you to locate providers of background music, install an SCA generator, begin subcarrier service and, with any luck, collect a handsome fee for the use of your spectrum. However, with "elevator music" approaching market saturation, that option is sometimes difficult to exercise.

But don't despair. There are other options. New applications for SCA operations are appearing as technical innovation breathes life into subcarrier transmissions.

In the 1990s, high bit-rate data transmission will be one of the keys that unlock the door to greater revenue through use of FM spectrum. Over the next decade, the words "data" and "SCA" promise to fit together like hand-in-glove.

Data to the rescue

One of the earliest applications of SCA was transmission of facsimile data. However, the bit rate was extremely low by today's standards. Today, with conventional SCA channel bandwidth, data rates of 9,600b/s are possible, and using the maximum available bandwidth for SCA could yield data rates in the 19,000b/s range.

In 1983, deregulation swept through the broadcast industry, bringing about many expected and some unexpected changes.

Kurz was a consulting technical editor for **BE** when he prepared this article.

Among those changes was an elevation of the ceiling on data speed transmitted via SCA. Over the past few years, equipment manufacturers have sought to market high-speed data SCA generators, and entrepreneurs have looked for a way to cash in on the faster data rates.

New services possible

Today, radio broadcasters have been exposed only to the tip of this high data rate iceberg in the form of national data networks such as the Indesys Data Broadcast Network and Bonneville's Radio Data Systems. Below the surface of this technological drift lies a multitude of variations on the theme for both data network communications and private commercial use by stations.

For instance, a broadcaster in the enviable position of being sold out could use an SCA data network to transmit information to its retail advertisers. Data bursts containing information such as current weather conditions, news headlines and traffic conditions could be transmitted via SCA every 15 minutes. Advertisers equipped with SCA receivers would capture the data and display it within their stores on scrolling message boards.

Of course, the cost of this service would be in addition to the price of commercial airtime. The benefit to the retailer in attracting customers interested in the information should outweigh the out-of-pocket expense. This application and hundreds of others yet to be thought of promise to make the future of SCA exciting.

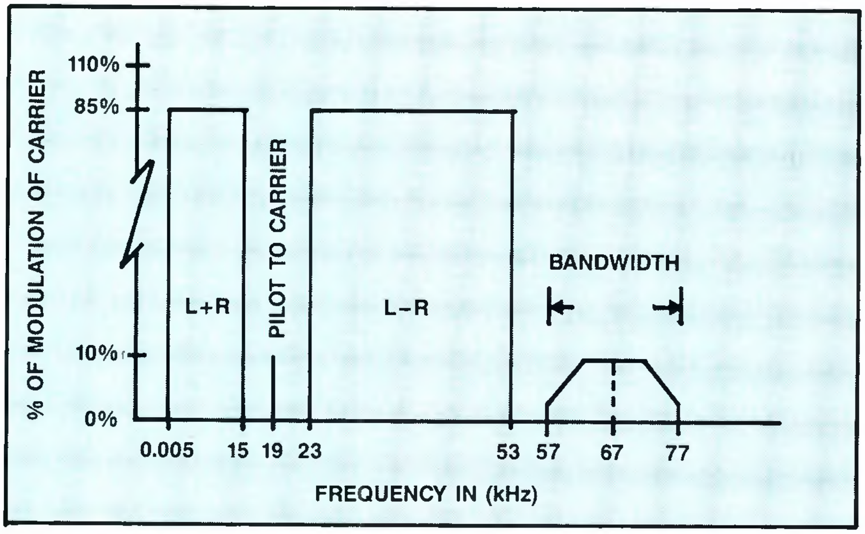
SCA background

In the early 1980s, the FCC deregulated SCA operations. At that point, the commission quit tracking the number of stations using their FM sidebands for SCA service. Because of this, detailed information on nationwide use of SCA technology is sketchy at best.

Although there are no rules specifying what carrier frequency should be used for SCA operations, certain criteria were imposed to limit interference to other baseband signals. For instance, the commission has ruled that the occupied bandwidth of an SCA signal is the bandwidth containing 99.5% of the total energy of the signal. This has been interpreted to mean the bandwidth of the signal between the points where the signal amplitude is 25dB below the unmodulated SCA subcarrier. In the real world, this traditionally has meant that SCA signals occupy 20kHz of bandwidth, although this has begun to change.

Traditionally, the center frequencies used most commonly for SCA operations have been 67kHz and 92kHz. (Many of the newer SCA data generators on the market today are designed to operate on different center frequencies.) The use of a 67kHz center frequency and SCA channel bandwidth of 20kHz allowed stations to avoid the upper edge of the L−R channel by 4kHz and still permitted another, higher SCA channel.

Likewise, a 92kHz carrier allows for 5kHz of separation from the 67kHz subcarrier on the low end and a top end of 102kHz. This upper end is 3kHz beyond the maximum permitted by the FCC for significant sidebands. However, this second-order sideband is not considered significant because it is 25dB below the



Courtesy of Modulation Sciences

Figure 1. The standard 67kHz subcarrier deviation extends down to approximately 57kHz. Any excursion of the signal into the L−R region produces crosstalk.

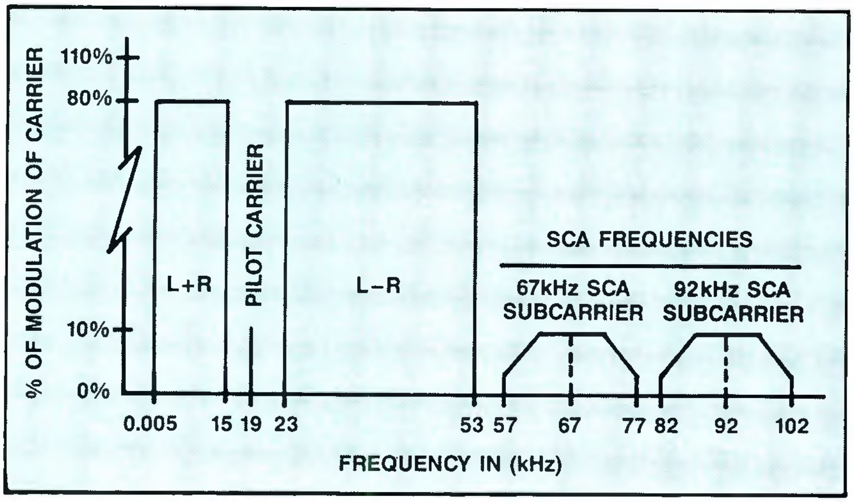


Figure 2. The standard configuration of two SCA carriers places them at 67kHz and 92kHz respectively. Because the upper sidebands of the 92kHz carrier are reduced greatly, the modulation at 102kHz is not considered significant by FCC definition and, therefore, is legal.

unmodulated SCA subcarrier.

Modulation techniques

Four basic modulation schemes are used today:

- *Subcarrier frequency modulation by baseband*, often called *FSK on FM on FM* or *triple modulation*.
- *Direct FSK on FM.*
- *AM on FM.*
- *Wideband direct linear suppressed carrier modulation.*

Each technique has its own strengths and weaknesses that make it suitable for certain applications.

The FSK-on-FM-on-FM scheme, also known as triple modulation, traditionally has been used for transmission of audio subcarriers. This method of SCA transmission takes an audio input into an FM modulator centered at either 67kHz or 92kHz. The output of this device is fed into the SCA input of the exciter for transmission.

The primary advantage of this technique is that it is a proven workhorse. It was used with the earliest SCA music applications. The technology also is rather inexpensive and widely available. Another advantage is that many of today's SCA generators using this frequency-modulation scheme include audio-processing circuitry.

The triple modulation method is limited in respect to bandwidth. As discussed previously, the 20kHz bandwidth allotted for SCA channels using FSK on FM on FM allows only two SCA channels to be transmitted on a single FM carrier. If maximization of SCA bandwidth is a high priority, then FSK on FM on FM may not be the most appropriate SCA scheme to choose.

Narrowband AM on FM often is reserved for data-transmission applications involving relatively low-rate data, such as the rate required for paging systems. In general, the data rate attainable with this application is about 1187.5 baud. An example of this scheme is the Swedish Televerket paging system.

Another popular method in applications in which large amounts of data must be moved quickly is direct FSK on FM technique. In this scheme, streams of data are filtered through low-pass filters. These streams of data then directly modulate a VCO. Data rates up to 9,600b/s can be achieved using a traditional 20kHz SCA channel.

If all the channel above 53kHz is used, data rates of as high as 19,200b/s are possible. This technique offers some advantages over other methods of SCA subcarrier generation. Perhaps its greatest advantage is its efficient use of bandwidth.

Even higher data rates can be achieved by using wideband direct linear suppressed carrier modulation. This method, which uses suppressed carrier vestigial sideband modulation, is capable of achieving 30,000b/s even after bits have been used for error correction. Not every data network will need such a high data rate. However, such speed makes it possible to simultaneously operate up to five asynchronous 4,800-baud SCA datastream networks.

Practical examples

These data rates make possible the creation of private and public computer networks. This is especially true where the network has one sender and a host of receivers.

Such was the case when Indesys, Sunnyvale, CA, kicked off its Data Broadcast Network. The company established its nationwide network using satellite transmission to relay the data to downlink sites at key locations around the country. Fifteen local FM broadcasters currently transmit the data via their SCA subcarrier to subscribers.

Data sent on the network is encrypted and forward error corrected to ensure reliable and accurate decoding. The information is broadcast twice to further reduce the chance of errors. Members of the network can choose between three types of receivers: a card that fits into a PC-compatible computer, an external FM receiver or a satellite receiver.

Interference

A debate is raging between proponents of wideband direct linear suppressed carrier modulation systems and supporters of the triple modulation technique. Ironically, the greater bandwidth used by the

the common denominator

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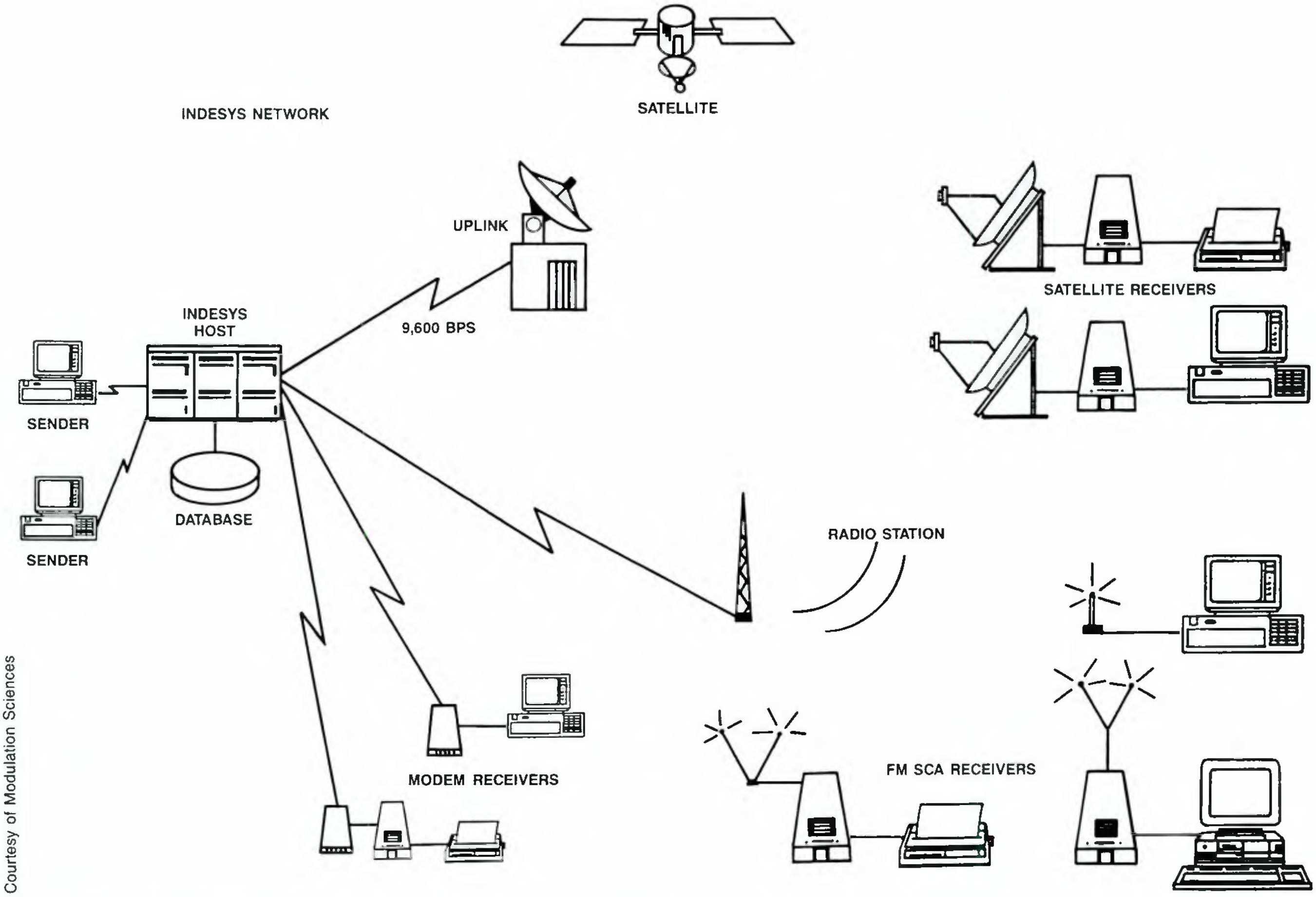

Courtesy of Modulation Sciences

Figure 3. *The Indesys network relies on satellite transmission to relay the data to local FM stations. The stations then relay the data to members via SCA transmission.*

wideband direct linear suppressed carrier technique could cause the technique's demise, argue proponents of triple modulation. They claim that one of the chief reasons 67kHz and 92kHz were chosen for carrier frequencies was that they do not produce crosstalk between the SCA channels, or worse yet, "birdies" (those high-pitched whistles heard in the main stereo channel resulting from interference caused by the SCA channel) into the main stereo channel.

Many broadcast engineers may remember the diode-bridge stereo decoders used in FM consumer receivers 15 to 20 years ago. The decoders often produced the dreaded birdies, which were blamed on the station. Fortunately, the introduction of phase-locked loop circuitry into modern stereo decoders greatly reduced the problem.

Unfortunately, birdies still can occur for a variety of reasons. Some engineers claim that the use of SCA carrier frequencies other than 67kHz and 92kHz can produce the interference. Proponents of the wideband suppressed-carrier modulation method argue that the concern about creating birdies is a red herring. They claim that multipath is the chief culprit in the creation of birdies.

It may be some time before all the answers are available. For now, engineers should simply be aware of the potential for problems. Begin any project with careful planning and design of the SCA system. Look at every element and the potential for problems, beginning with the audio or data input to receiver output.

Also, look at your transmission system. Just because the transmitter appears clean to stereo audio is no guarantee that it will handle SCA without degradation. As any engineer familiar with SCA will tell you, proper transmitter maintenance and tuning is not just important — it's often the difference between a system that works and one that doesn't.

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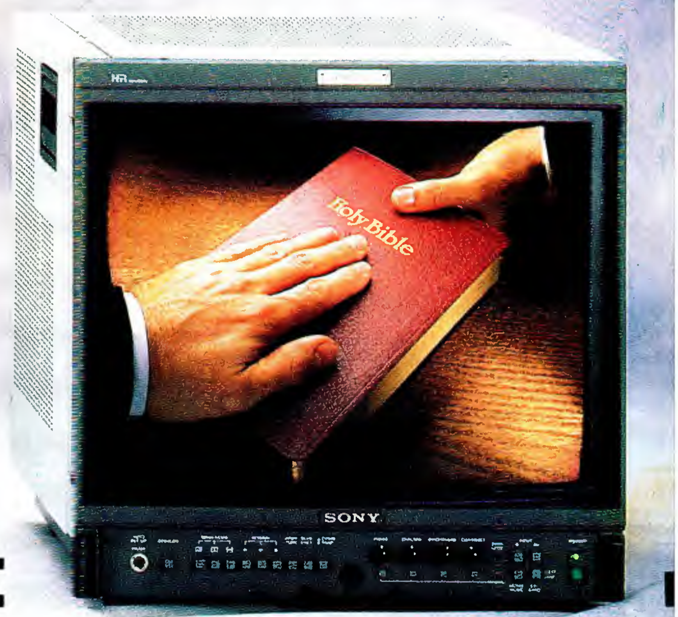

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BROADCAST PRODUCTS

The mechanisms of tape wear

By Richard Maddox

Keep tape clean to make it last.

Considering what we put tape through, it's a wonder that it holds up at all. During manufacturing we stretch it, squish it and attack its surface with solvents, then we slow-cook it, like a ham in a smokehouse. When the tape is fully cured, we slit it to size and wind it up on itself, only to spool it off once again onto the finished reels or cassettes. Then we pass it through the tortuous path of a tape machine for recording and heaven knows how many playbacks, or else stick it on a shelf to languish in an archive. Through all of this, tape holds up remarkably well. But still, there is wear and tear, and where there is fatigue, there lurks the possibility of failure.

At best, the useful life of a tape can be long indeed. The space-born tape recorders that fly on Earth-observation satellites and the space shuttle, cousins to the broadcasters' multitrack ATR, have been known to rack up more than 40,000 hours of usage on the same reel. At worst, in the harsh environment of a remote van, in electronic news gathering or in facilities where technical details are handled carelessly, three months on a reel is considered good.

Two ways to wear out

Tape wear can be broken down into two categories: short term and long term. Short-term wear is physical wear caused by handling and tape-transport mechanisms. In most cases, it can be avoided. Long-term wear is caused by oxidation and chemical degradation and is really only a factor with archival tapes. Long-term wear can be minimized with proper storage, but cannot be eliminated.

Maddox is chief studio engineer with Muzak in Seattle.

Physical structure

All types of modern recording tapes start with a base film. This most often is a polyester, such as polyethylene terepthalate (PET). PET is a stable substance, especially when compared with acetate base film. Acetate was popular through the 1960s for magnetic recording, but is used today only as a base for motion-picture film. Acetate deteriorates with age, so any archival tapes made of acetate should be dubbed over to PET base tape.

The PET used in manufacturing videotapes is slightly different from that used in making audiotapes, because of the different tensile properties required for each. Professional audiotape base film is generally about 1,000 microinches thick.

Courtesy of Odetics

Space tape recorders, such as this one used in the SPOT series of Earth-observation satellites, achieve long tape life through cleanliness and careful engineering. Machines such as this one have logged up to 40,000 hours on the same reel.

Typically, the base film for videotape is between 360 and 800 microinches thick. Within each broad category — audiotape vs. videotape — there are variations. Individual base film properties such as elasticity, humidity absorption, stiffness, smoothness and thickness will vary according to the end use.

During manufacturing, this base film is precisely coated with a mixture of oxide or metallic particles (which do the actual recording), lubricants (to ensure smooth wrapping and ease tape-head travel) and abrasives (to keep tape heads clean). Other chemicals are added to ensure proper binding of the magnetic coating to the base film. The magnetic coating is typically 100 to 400 microinches thick.

A backcoat is applied on the opposite side of the base film. The backcoat has three duties: to protect the base film, to act as an anti-static coating and to ensure the tape will roll into a good, even tape pack. The backcoating is 40 to 80 microinches thick.

Dropout

The most common short-term problem with recording tape is dropout. A dropout occurs whenever the tape-to-head contact is momentarily lost or when the magnetic coating is defective. Except for certain manufacturing irregularities where the base film or the magnetic coating is faulty, dropouts usually can be prevented by proper cleaning, handling and setup of the equipment the tape is played on.

For the most part, dropouts are caused by tape handling. Dust, fingerprints, smoke, food particles and dirt are common culprits. Using lint-free gloves to

thread tapes will prevent fingerprint-caused dropouts. It is not the fingerprint itself that causes the dropout, but the fact that it acts as a perfect dust and lint trap. Even if only the backcoating were touched, dropouts still could occur because the next wrap's oxide side would be against the printed spot. This problem is seen on audiotape that has been marked with grease or wax pencils. The grease and wax can form holding areas for dust and lint. This can migrate to transport guides or heads and be transferred to other tapes.

A big cause of dropouts in multipass tapes is magnetic coating that is knocked off the tape by worn tape guides, heads and warped reel flanges scraping the tape. These microscopic bits of coating are redeposited on the recording surface, causing momentary head-to-tape separation. Another culprit is damaged tape ends that whip around after rewind. They should be trimmed frequently, to prevent coating deposits on the transport or heads. Cleaning the tape path after each pass is optimal, with a minimum of once each shift. Use lint-free cotton swabs or Kimwipes and an approved solvent.

These precautions, as well as storing tape in sealed plastic bags that are opened only in the environment in which the tape will be played, will virtually eliminate the causes of dropout as long as the studio environment is kept smoke-free and has a positive pressure flow.

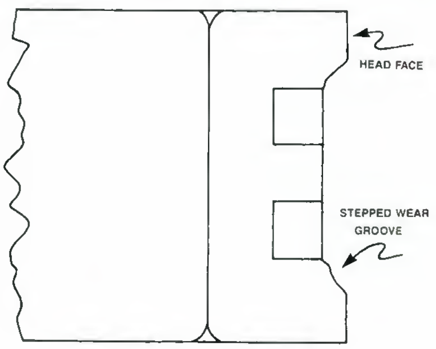

Figure 1. *Head wear causes tape edge damage, which in turn leads to dropout, flutter and warble.*

Mechanical damage

Outside of dropping a reel or cassette, most short-term physical damage to the tape takes place during actual recording or playback. Tape guides that are worn can cause the tape to cup or to drift up and down and cause scratches in the backcoating or in the magnetic coating.

A worn head can cause the same problems. Wear on audio heads is easy to see. As a rule, if you can catch a thumbnail on the wear edge, it's already too much. (See Figure 1.) Video heads must be removed to be visually inspected under a microscope, which usually means that damage caused by video head wear can occur for weeks before it is caught.

Head wear can be aggravated by improper tape handling. High humidity can increase head wear because of the added moisture content in the tape binder. Tape that is physically damaged (crumpled, creased or scratched) can cause head wear rates of up to 400 microinches per hour.

Tape that is subjected to high temperatures and high humidity (95°F, 90% relative humidity) will physically lengthen. When it is placed in a cool, dry environment (50°F, 40% relative humidity), it will attempt to shrink back to its original length, which could be up to six feet shorter. This creates a tremendous pressure on the pack, which can cause cinching and pack slippage.

Playing damaged sections of tape not only increases head wear, but also in-

Continued on page 90

BROADCAST NEWS!

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creases the tape wear through oxide build-up on the tape and through magnetic-coating scratches. Severe scratches can even deform the backcoating.

Storage

Because tapes are hygroscopic (moisture-absorbent), they must be kept at a constant temperature and humidity to maintain their quality. The ideal storage room will be kept at 21°C (70°F) with a relative humidity of about 40%. Temperatures below this point are acceptable as long as freezing does not occur. Humidity above 50% is not recommended. After removal from storage, tape should be allowed to acclimatize itself in the play environment for 24 hours.

Both audiotape and videotape reels and cassettes should be stored vertically. Even relatively short periods of horizontal storage can cause 10-inch NAB reel flanges to warp if pressure is applied (caused by stacking several tapes on top of one another).

Before long-term storage, all tapes should be kept in a cool and dry environment for 48 to 72 hours. Once they have been preconditioned, they should be placed in a sealed bag or container to minimize temperature and humidity changes and to prevent dust build-up. Special metal-coated sealing bags for tape archiving are available, although using zip-type freezer bags will be sufficient for most uses where humidity is below 50%.

Archive tapes should be spooled forward periodically and rewound. This helps loosen tension that might build up as the tape pack settles over time. (See Figure 2.) A further advantage to this process is that it protects against print-through, because the tape pack is unlikely to realign itself exactly where it was. When playing back or rewinding an archival tape, be sure to allow at least eight hours of conditioning time in the room in which it is to be played.

Machine area

For maximum use with minimum wear, all tape should be played back in as clean a room as possible. Air-conditioning and air-filtration is absolutely essential. Whenever practical, the room in which tapes are played should have air pressure greater than the hallways surrounding the room. This is called having a "positive pressure."

Floors should have a hard surface, such as vinyl or tile, rather than carpeting. This minimizes static build-up as well as lint and dust build-up caused by carpeting.

Averting disaster

We don't live in an ideal world, and accidents are bound to happen. Here are some ways to get around some common tape misfortunes:

- *Exposure to high temperatures.*

High temperatures, probably the most frequent cause of tape damage, are encountered during the shipping of tapes around the countryside. On a hot day, the interiors of cars and trucks can rise quickly to 160°F. In most cases, no permanent damage is done to the tape, but because cassettes can warp at 120°F and plastic reels warp at about 150°F, there may be mechanical problems during playback. If the tape has been subjected to extreme temperatures, cool it down for at least one day at 60°F or below before using.

- *Print-through.*

The severity of print-through is determined by the level of the original recording, by the temperatures the tape has been subjected to, by how long the tape has been stored, by the thickness of the tape, by the frequencies that are recorded and by any magnetic fields that it may have

encountered.

To minimize print-through, store the tape at temperatures below 70°F, use standard-length tapes (extra-long play tapes are thinner) and be sure to leave the tape wound "tails out." You can reduce existing print-through by rewinding through the tape a couple of times before playing.

- *Squeaking tapes.*

This indicates that the lubricant has migrated out of the magnetic coating. Pass the oxide side of the tape across a pad soaked with a solution of 1% Krytox and 99% Freon TF to relubricate the tape for immediate playback.

- *Loose pack.*

Never fast forward or rewind tape in a loose pack because this can cause stretching. Play the tape through to the end. If it was stored "tails out," then you must play the tape through twice.

- *Water.*

It doesn't take long for fungus to form when moisture is present. If the tape has been saturated, then it should be placed in a warm oven (120°F/50°C) for 24 hours. Let it cool to room temperature, then shuttle the tape back and forth through the reel.

X-ray machines and loudspeaker myths

Many people think that airport X-ray machines can damage tapes. This is false. Even the hand-held metal detectors emit a magnetic field that is too small to affect magnetic tape.

The same is true for turntables, cartridges, tape-transport motors and other transformers, motors and generators. They are designed to focus the magnetic field in a tight pattern (transformer core or motor windings) and, unless the tape was placed directly on them for an extended period of time, no measurable degradation would occur.

Inside metal-particle tape

By Rick Lehtinen, TV technical editor

What's inside metal-particle tape? This isn't a trick question, like "Who's buried in Grant's tomb?" The secret ingredient in metal-particle tape is just that: quite secret. It centers on the design and choice of particles and binder systems. Even if you learned the brew's ingredients, enough of the magic is in the method of manufacture that you probably couldn't duplicate the results. There are some similarities across all brands, though.

In the first place, metal-particle tape uses metal particles, not metal oxides. Only about one-third of each iron oxide particle is magnetic. Using metal instead of oxide thereby boosts the retentivity (the strength of the magnetic field that remains in the tape after the recording head has passed) of the tape by a factor of three. Second, the particles all will be somewhat alike. Generally, they will be iron and have a coercivity (magnetic strength) of 1,500 Oe, about twice that of type C or U-matic tape. They will be shaped like little needles, about eight times longer than they are in diameter. Some of the characteristics that differentiate the tapes made by various manufacturers are the quality of the base film, the uniformity with which the binder system (the "glue" that hooks the magnetic coating to the base film) is applied, and the precision of the tape-slitting operation, where the several-foot-long "jumbo rolls" are cut down to finished dimensions.

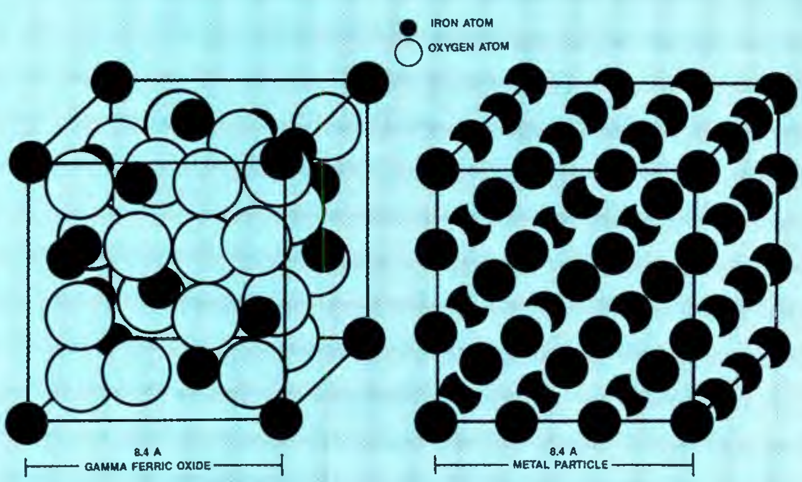
Also, some care has been taken along the way to keep the tape from setting itself on fire. The extremely small bits of metal used in tape (0.15m to 0.5m) have tremendous surface area. (One gram, about a drop, has as much surface area as a basketball court.) Large surface area facilitates exposure to atmospheric moisture.

Metal rusts. Rust is oxidation. The only difference between rust and fire is the speed with which it happens. Fire is good in boilers, but should be avoided in tape rooms. In order to avoid conflagrations, manufacturers use only treated particles. These generally have been allowed to rust under carefully controlled circumstances.

Courtesy of Ampex Recording Media

Photomicrograph of metal particles used in the manufacture of metal-particle tape, at a magnification of 70,000 times.

The outer layer of rust isolates the rest of the particles from the environment, preventing oxidation. The oxidized particles are then coated with resin. The manufacturers ship particles in sealed drums, and are likely to work with and store the particles in solution or under nitrogen curtains. But by the time the particles are resin-coated and mixed with the other lubricants, abrasives and dispersants of the finished tape product, the tape is no more flammable than any standard oxide tape.



Iron oxide crystal contains more oxygen, therefore, less iron than metal particle. This means metal-particle tape retains more of the magnetizing signal.

Acknowledgment: The author wishes to thank Irv Wolf, principal engineer, Ampex Recording Media, Redwood City, CA, for assistance in the preparation of this article.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Another misconception is that placing tapes on TV monitors or loudspeakers will almost immediately cause dropouts or partial erasure. Again, the fields are small and concentrated, and normally the tapes don't come anywhere near having a magnetic field strong enough to cause problems. But if the tape is left for an extended period of time (overnight or longer) on or right next to a bass speaker cabinet, there is a possibility of print-through being increased and some audible decrease in signal-to-noise ratio at the point nearest the speaker.

The National Bureau of Standards did some experiments during its research on erasing magnetic tapes. It found that a 2,500 gauss hand-held magnet will cause only a 5% loss of signal when held two inches from the tape. The bureau also found that subjecting a tape to an electromagnet with 800-pound lifting capacity (such as those found in metal recyclers) also will cause only about a 5% signal loss. A 5% loss is about 0.5dB, virtually unnoticeable.

With today's metal-particle and evaporated metal tapes, the loss due to magnetic fields is an even smaller factor in tape wear. With metal tapes (such as DAT, Betacam, M-II and D-2), it's often a case of not having a bulk eraser strong enough to thoroughly erase them!

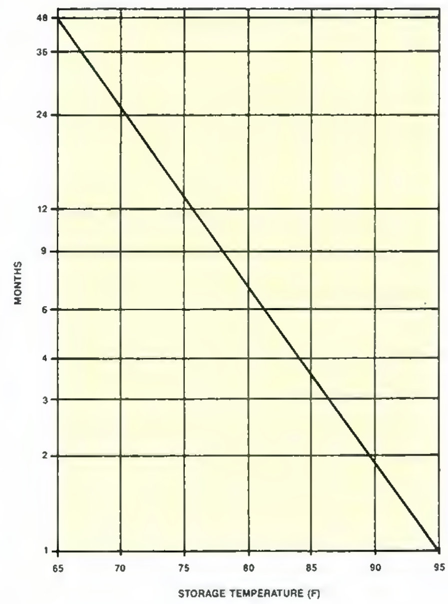


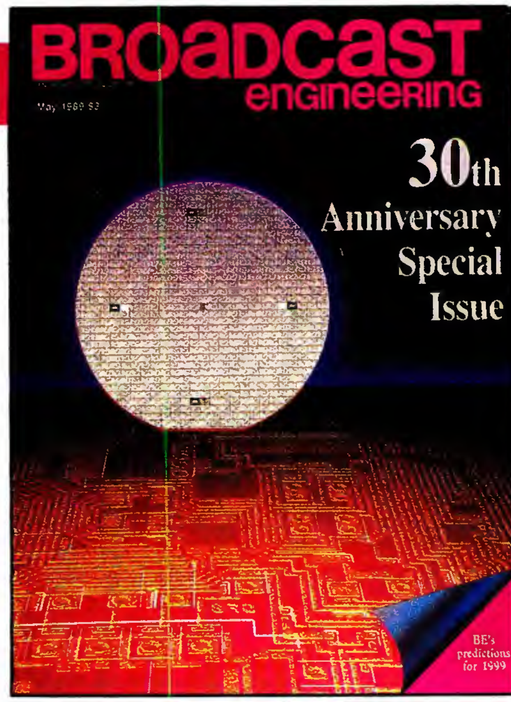
Figure 2. *Estimated rewind interval for archived tapes as a function of temperature. Other factors may dictate more frequent rewinding.*

Handle with care

Most tape wear is caused by poor handling and storage rather than mechanical wearing away of the magnetic coating during recording and playback. The noticeable dropouts that seem to increase over the life of a tape typically are caused by dirt and mechanical damage. The damage occurs as the tape is passed over worn guides, idlers and heads, and as it is loaded and unloaded.

To minimize tape wear you also must look beyond the tape and tape-machine transport to the room environment, the storage environment and the handling procedures. Proper preventive maintenance of the tape-transport mechanism, with special attention to guide and head wear, also is an integral part of minimizing tape wear.

The revolution of television



By Jerry Whitaker, editorial director

From humble beginnings, television has become the most effective communications medium in the history of this planet.

"Standardization at the present stage is dangerous. It is extremely difficult to change a standard, however undesirable it may prove, after the public has invested thousands of dollars in equipment. The development goes on, and will go on. There is no question that the technical difficulties will be overcome."

The writer is not addressing the problems faced by high-definition television or fiber-optic delivery of video to the home. The writer is addressing the problems faced by *television*. The book containing this passage was published in April 1929. Technology changes, but the problems faced by the industry do not.

The mass communications medium of television is one of the most significant technical accomplishments of the 20th century. The ability of persons across the country and around the world to *see* each other, to communicate with each other and to experience each other's cultures and ideas is a monumental development. Most of us have difficulty conceiving of a world without instant visual communication to virtually any spot on earth. The technology that we enjoy today, however, required many decades to mature.

The Nipkow disc

The first working device for analyzing a scene to generate electrical signals suitable for transmission was a scanning system proposed and built by Paul Nipkow in 1884. The scanner consisted of a rotating disc with a number of small holes (or *apertures*) arranged in a spiral, in front of a photo-electric cell. As the disc rotated, the spiral of 18 holes swept across the image of the scene from top to bottom in a pattern of 18 parallel horizontal lines. Figure 1 shows an outline of the 18-line Nipkow scanning system.

The Nipkow disc was capable of about 4,000 picture "dots" (or pixels) per second. The scanning process analyzed the scene by dissecting it into picture elements. The fineness of picture detail that the system was capable of resolving was limited in the vertical and horizontal axes by the diameter of the area covered by the aperture in the disc. For reproduction of the scene, a light source controlled in intensity by the detected electrical signal was projected onto a screen through a similar Nipkow disc rotated in synchronism with the pickup disc.

Despite subsequent improvements by other scientists (J. L. Baird in England and C. F. Jenkins in the United States) and in 1907 the use of Lee De Forest's vacuum-tube amplifier, the serious limitations of the mechanical approach discouraged any practical application of the Nipkow disc. The principal shortcomings were:

- inefficiency of the optical system.
- use of rotating mechanical components.
- lack of a high-intensity light source capable of being modulated by an electrical signal at the higher frequencies required for video signal reproduction.

Nevertheless, Nipkow demonstrated a scanning process for the analysis of images by dissecting a complete scene into an orderly pattern of picture elements that could be transmitted by an electrical signal and reproduced as a visual image. This approach is, of course, the basis for present-day television.

Nipkow lived in Berlin, although he was of Russian birth. The U.S.S.R. claims a Russian invented television, not because of Nipkow, but because of another man who experimented with the Nipkow disc in 1905 in Moscow. The Germans, English and Japanese also claim their share of the fame for inventing television.

No one disputes, however, that credit for the development of modern *electronic* television belongs to two men: Philo T. Farnsworth and Vladimir Zworykin. Each spent their lives perfecting this new technology.

Continued on page 100

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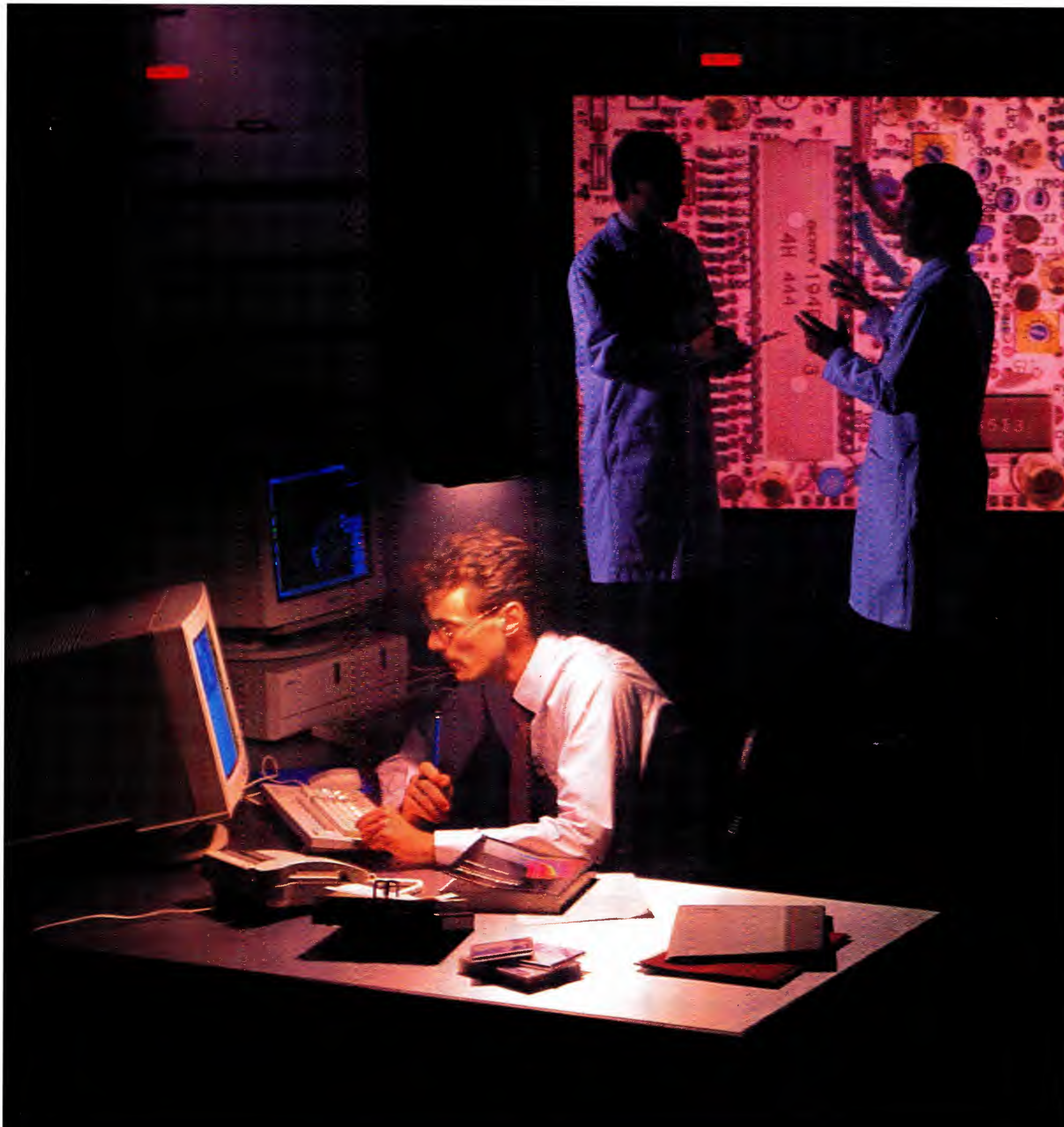

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Zworykin: the brains of RCA

Vladimir Zworykin immigrated to the United States after World War I and went to work for Westinghouse in Pittsburgh. During his stay at the company — 1920 until 1929 — Zworykin performed some of his early experiments in television. He had left Russia for America to develop his dream: television. His conception of the first practical TV camera tube, the *iconoscope* (1923), and his development of the *kinescope* picture tube formed the basis for subsequent advances in the field. Zworykin is credited by most historians as "the father of television."

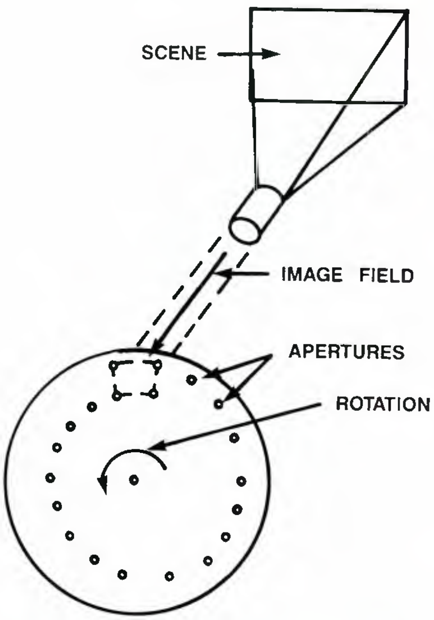

Figure 1. *The primary elements of the Nipkow disc TV system using spiral scanning apertures.*

Zworykin's iconoscope (from Greek for "image" and "to see") consisted of a thin aluminum-oxide film supported by a thin aluminum film and coated with a photosensitive layer of potassium hydride. With this crude camera tube and a CRT as the picture reproducer, he had the essential elements for electronic television.

Continuing his pioneering work, Zworykin developed an improved iconoscope six years later that employed a relatively thick, 1-sided target area. He had, in the meantime, continued work on improving the quality of the CRT and presented a paper on his efforts to the Eastern Great Lakes District Convention of the Institute of Radio Engineers (IRE) on Nov. 18, 1929. The presentation attracted the attention of another Russian immigrant, David Sarnoff, then vice president and general manager of RCA. Sarnoff persuaded Zworykin to join RCA Victor in Camden, NJ, where he was made director of RCA's electronics research laboratory. The company provided the management and financial backing that enabled Zworykin and the RCA scientists working with him to develop television into a practical system.

Dr. Vladimir Zworykin, shown in this 1910 photo, is widely acclaimed as the father of television. His iconoscope camera tube and kinescope CRT pioneered modern electronic television.

Neither of the men forgot their first meeting. In response to a question from Sarnoff, Zworykin — thinking solely in research terms — estimated that the development of television would cost $100,000. Years later, Sarnoff delighted in teasing Zworykin by telling audiences what a great salesman the inventor was. "I asked him how much it would cost to develop TV. He told me $100,000, but we spent $50 million before we got a penny back from it."

By 1931, with the iconoscope and CRT well-developed, electronic television was ready to be launched, and Sarnoff and RCA were ready for the new industry of television.

Farnsworth: the boy wonder

Legend has it that Philo Farnsworth conceived of electronic television when he was a 15-year-old high school sophomore in Rigby, ID, a small town about 200 miles north of Salt Lake City. Farnsworth met a financial expert by the name of George Everson in Salt Lake City when he was 19 years old and persuaded him to try to secure venture capital for an all-electronic TV system.

Although Everson was able to convince financial investors to put up money for this unproved young man with unorthodox ideas, they were concerned that no one else was investigating an electronic method of television. Obviously, many people were interested in capturing the control over patents of a vast new field for profit. If no one was working on this method, then Farnsworth had a clear field. If, on the other hand, other companies were working in secret without publishing their results, then Farnsworth would have little chance of receiving the patent awards and the royalty income that surely would result. Farnsworth and Everson were able to convince the financial backers that they alone were on the trail of a total electronic TV system.

Farnsworth established his laboratory first in Los Angeles and later in San Francisco, at the foot of Telegraph Hill. Farnsworth was the proverbial lone basement experimenter. It was at his Green Street (San Francisco) laboratory that Farnsworth gave the first public demonstration in 1927 of the TV system he had dreamed of for six years.

And he was not yet 21 years of age!

Farnsworth was quick to develop the basic concepts of an electronic TV system, giving him an edge on most other inventors in the race for patents. His patents included the principle of blacker-than-black synchronizing signals, linear sweep and the ratio of forward sweep to retrace time. Zworykin won a patent for the principle of field interlace.

In 1928 Farnsworth demonstrated a nonstorage electronic pickup and image-scanning device he called the *Image Dissector.* The detected image was generated by electrons emitted from a photocathode surface and deflected by horizontal and vertical scanning fields (applied by coils surrounding the tube) so as to cause the image to scan a small aperture. In other words, rather than an aperture or electron beam scanning the image, the aperture remained stationary, and the electron image was moved across the aperture. The electrons passing through the aperture were collected to produce a signal corresponding to the charge at an

Zworykin (1940) is shown holding an early model of the iconoscope, which he developed as the all-electronic eye of the TV camera.

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element of the photocathode at a given instant. (See Figure 2.)

The limitation of this invention was the extremely high light level required because of the lack of storage capability. Consequently, the Image Dissector found little use other than as a laboratory signal source. Still, in 1930, the 24-year-old Farnsworth received a patent for his Image Dissector, and in the following year entertained Zworykin at his San Francisco laboratory.

Farnsworth's original "broadcast" included the transmission of graphic images, film clips of a Dempsey-Tunney fight and scenes of Mary Pickford combing her hair (from her role in the "Taming of the Shrew"). In his early systems, Farnsworth could transmit pictures with 100- to 150-line definition at a repetition rate of 30 lines per second. This pioneering demonstration set in motion the progression of technology that would lead to commercial broadcast television a decade later.

Farnsworth held many patents for television, and through the mid-1930s remained RCA's fiercest competitor in developing new technology. Indeed, Farnsworth's thoughts seemed to be directed toward cornering patents for the field of television and protecting his ideas.

In the late 1930s, fierce patent conflicts between RCA and Farnsworth flourished. They were settled in September 1939 when RCA capitulated and agreed to pay continuing royalties to Farnsworth for the use of his patents. The action ended a long period of litigation. By that time Farnsworth held an impressive list of key patents for electronic television.

Farnsworth died in 1971 and is credited only slightly for the giant industry that he helped create.

Continued on page 106

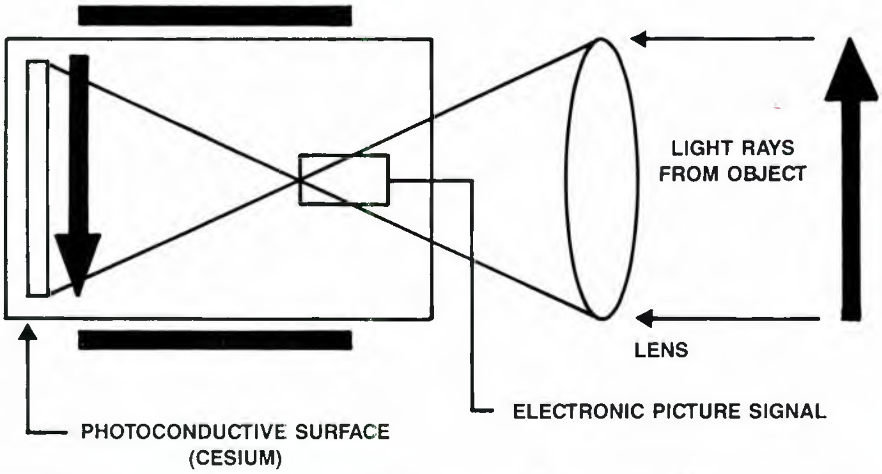
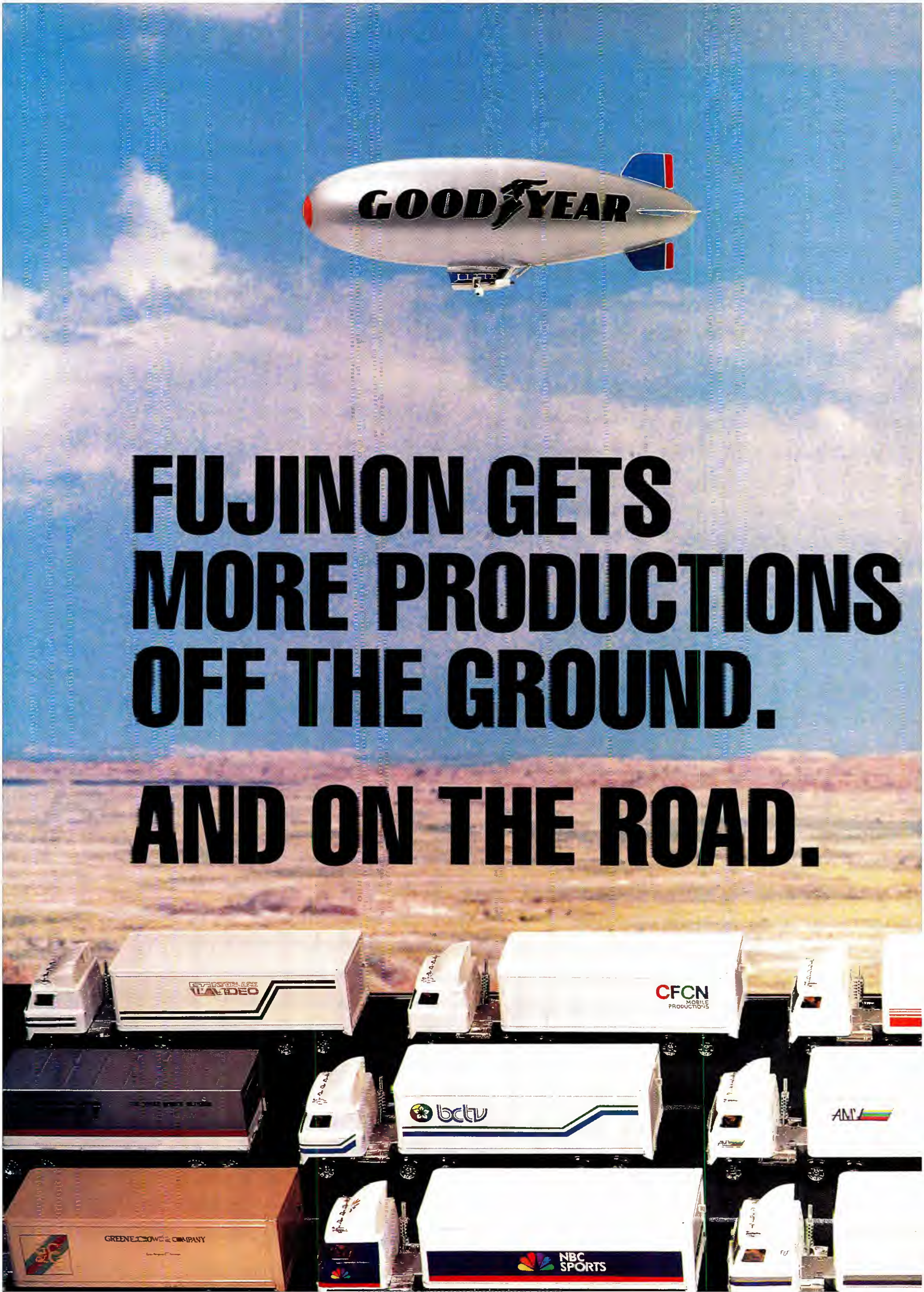


Figure 2. Basic construction of the Image Dissector tube. The lens focuses light on the photoconductive surface, and free electrons are caused to move to the electron collector by the scanning beam.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Other experimenters

Unsuccessful attempts were made to use pickup devices without storage capability, such as the Farnsworth Image Dissector, for studio applications. The most ambitious were the Allen B. DuMont Laboratories experiments in the 1940s with an electronic *flying-spot* camera. The set in the studio was illuminated with a projected raster frame of scanning lines from a cathode-ray tube. The light from the scene was gathered by a single photocell to produce a video signal.

The artistic and staging limitations of the dimly lit studio are all too obvious. Nevertheless, although it was useless for live pickups, it demonstrated the flying-spot principle, a technology that is widely used today for TV transmission of motion-picture film and slides.

General Electric also played an early role in the development of television. In 1926, Ernst Alexanderson, a young engineer at the company, developed a mechanical scanning disc for video transmission. He gave a public demonstration of the system two years later. Coupled with the GE experimental TV station, WGY (Schenectady, NY), Alexanderson's system made history on Sept. 11, 1928, with the broadcast of the first dramatic program on television. It was a 40-minute play titled "The Queen's Messenger." The program consisted of two characters performing before three simple cameras.

There was a spirited race to see who could begin bringing TV programs to the public first. In fact, the 525-line, 60Hz standards promoted in 1940 and 1941 were known as "high-definition television," as compared with some of the experimental systems of the 1930s. The original reason for the 30fps rate was the simplified receiver design that it afforded. With the field scan rate the same as the power system frequency, ac line interference effects were minimized in the reproduced picture. Both Zworykin and Farnsworth were members of the committee that came up with proposed standards for a national (U.S.) system. The standard was to be in force before any receiving sets could be sold to the public.

The two men knew that to avoid flicker, it would be necessary to have a minimum of 40 complete pictures per second; this was known from the motion-picture industry. Although film is exposed at 24fps, the projection shutter is opened twice for each frame, giving a net effect of 48fps. If 40 complete pictures per second were transmitted, even with 441 lines of horizontal segmentation (which was high-definition television prior to World War II), the required bandwidth of the transmitted signal would have been greater than the technology of the day could handle. The *interlace* scheme was developed to overcome the technical limitations faced by 1940s technology.

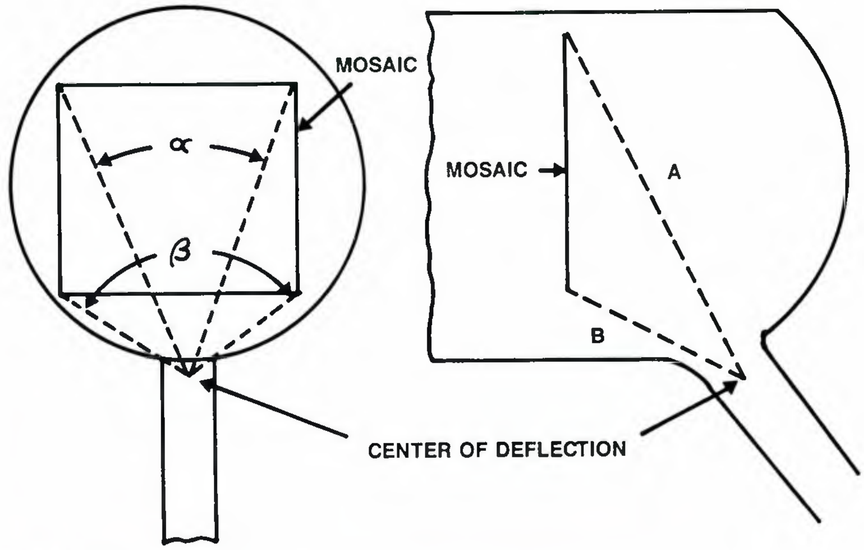

Figure 3. *The deflection geometry of the iconoscope pickup device.*

Pickup tubes

Zworykin's iconoscope TV camera tube, first patented in 1923, stored an image of a scene as a mosaic pattern of electrical charges. A scanning electron beam then released secondary electrons from the photosensitive mosaic to be read out sequentially as a video signal. (See Figure 3.)

Although the iconoscope provided good resolution, relatively high light levels (studio illumination of 500fc or more) was necessary. In addition, picture quality was degraded by spurious flare. This was caused by photo-electrons and secondaries, resulting from the high potential of the scanning beam, falling back at random on the storage surface. The presence of flare, and the lack of a reference black signal (because of capacitive coupling through the signal plate) resulted in a gray scale that varied with scene content. The pickup system thus required virtually continuous manual correction of video-gain and blanking levels.

Zworykin demonstrates an early electronic TV receiver using the kinescope picture tube (circa 1929).

Furthermore, because the light image was focused on the same side of the signal plate as the charge image, it was necessary to locate the electron gun and deflection coils off the optical axis to avoid obstructing the light path. Because the scanning beam was directed at the signal plate at an average angle of 45°, vertical keystone correction of the horizontal scan was needed.

With all its shortcomings, the iconoscope was the key to the introduction of the first practical all-electronic TV system. Because a cathode-ray picture-display tube (necessary to supplant the slowly reacting modulated light source and cumbersome rotating disc of the Nipkow display system) had been demonstrated as early as 1905, a TV system composed entirely of electronic components was then feasible.

Zworykin continued to refine the iconoscope, demonstrating improved tubes in 1929 and 1935. His work culminated in the development of the *image iconoscope* in 1939, which offered greater sensitivity and overcame some of the inherent problems of the earlier devices. In the image iconoscope, a thin-film transparent photocathode was deposited on the inside of the faceplate. Electrons emitted and accelerated from this surface at a potential of several hundred electronvolts were directed and focused on a target storage plate by externally applied magnetic fields. A positive charge image was formed on the storage plate, this being the equivalent of the storage mosaic in the iconoscope. A video signal was generated by scanning the positive charge image on the storage

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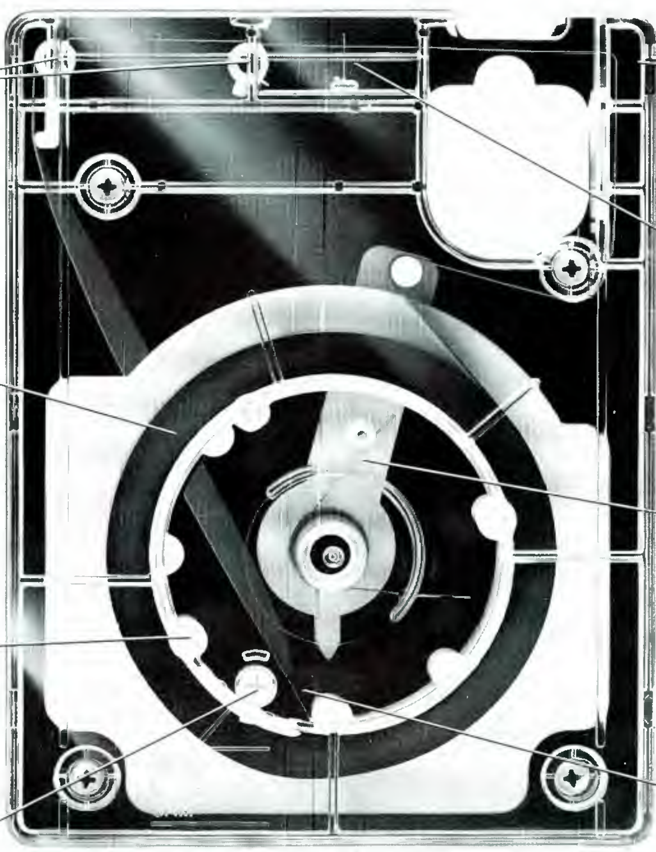

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plate with a high-velocity beam in exactly the same manner as the iconoscope.

Both types of iconoscopes had a light-input/video-output characteristic that compressed highlights and stretched lowlights. This less-than-unity relationship produced signals that closely matched the exponential input-voltage/output-brightness characteristics of picture display tubes, thus producing a pleasing gray scale of photographic quality.

The *orthicon* camera tube, introduced in 1943, was the next major development in tube technology. It eliminated many of the shortcomings of the iconoscope through the use of low-velocity scanning. The orthicon, so named because the scanning beam landed on the target at right angles to the charge surface, used a photoemitter composed of isolated light-sensitive granules deposited on an insulator. A similar tube, the *CPS Emitron* (so named for its *cathode-potential stabilized* target scanning), was developed in England. The CPS Emitron target was made up of precise squares of semitransparent photo-emissive material deposited on the target insulator through a fine mesh. Both of these tubes produced high-resolution pictures with precise gray scales.

In 1943, an improved orthicon pickup device, the *image orthicon*, was introduced. The tube incorporated three important technologies to make possible studio and field operations under reduced and varied lighting conditions. The technologies involved were the following:

1. Imaging the charge pattern from a photosensitive surface on an electron storage target.
2. Modulation of the scanning beam by the image charge of the target.
3. Amplification of the scanning-beam modulation signal by secondary-electron emission in a multistage multiplier.

Zworykin (1980) posing in front of David Sarnoff's portrait. Also a Russian immigrant, Sarnoff was instrumental in bringing Zworykin to RCA, thereby providing him the resources to develop electronic television. Zworykin credited Sarnoff with having the vision to foresee television as a new form of home entertainment.

Figure 4 shows the physical construction of the image orthicon. The image of the scene being televised is focused on a transparent photocathode on the inside of the tube's faceplate. The diameter of the photocathode on a 3-inch-diameter image orthicon was 1.6 inches (41mm), the same as double-frame 35mm film, a fortunate choice because it permitted the use of already-developed conventional lenses. Light from the scene caused a charge pattern of the image to be set up. Because the faceplate was at a negative voltage (−450V), electrons were emitted in proportion to scene illumination and accelerated to the target-mesh surface, which was at (nearly) zero potential. The fields from the accelerator grid and focusing coil focused the electrons on the target.

The *vidicon* was introduced to the broadcast industry in 1950. It was the first successful TV camera tube to use a photoconductive surface to derive a video signal. The photosensitive target material of the vidicon consisted of a continuous light-sensitive film deposited on a transparent signal electrode. An antimony trisulphide photoconductor target was scanned by a low-velocity electron beam to provide an output signal directly. No intermediate electron-imaging or electron-emission processes, as in the image orthicon or iconoscope, were employed.

Although a variety of tubes have since been developed and identified under different trade names (or by the type of photoconductor used), the name *vidicon* has become the generic classification for all such photoconductive devices. Milestones in this developmental process include introduction of the 1-inch Plumbicon in 1968, the 2/3-inch Plumbicon in 1974, the 1/2-inch Plumbicon in 1981 and the 1/2-inch Saticon also in 1981.

Solid-state imaging

Solid-state imaging devices using a flat array of photosensitive diodes were proposed as early as 1964 and demonstrated publicly in 1967. The charge voltage of each sensor element was sampled in a

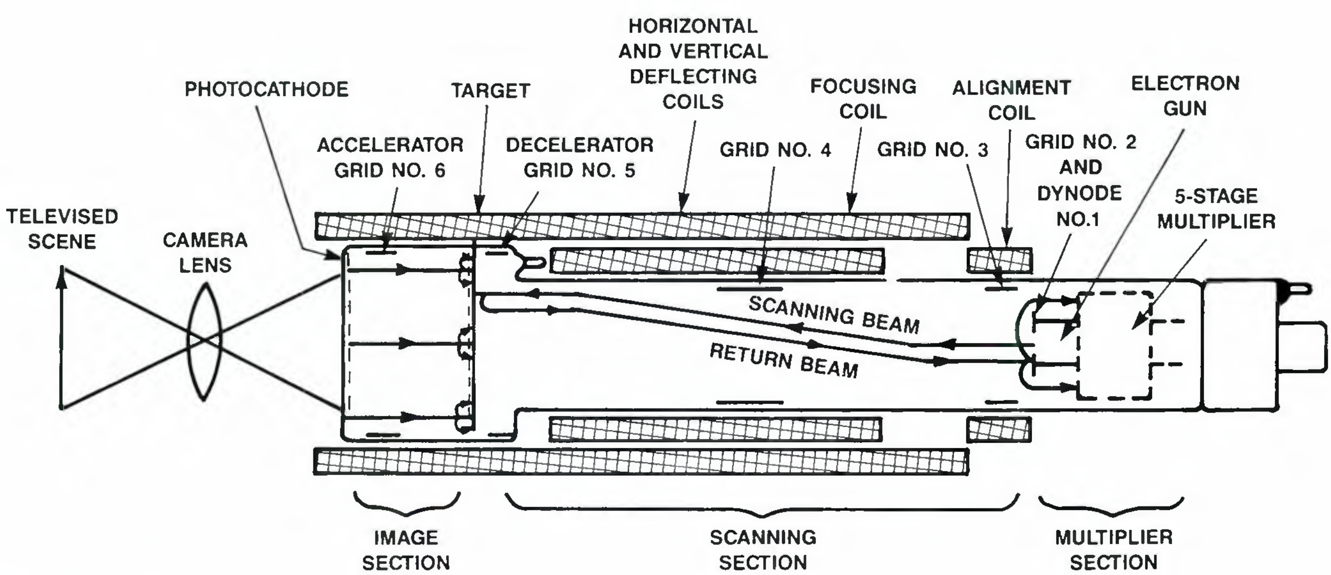

Figure 4. *Schematic cross-section of the image orthicon pickup device.*

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horizontal and vertical, or X–Y, addressing pattern to produce an output voltage corresponding to a readout of the image pixels. The resolution capability of these first laboratory models did not exceed 180×180 pixels, a 10th of that required for TV broadcasting applications. Nevertheless, the practicability of solid-state technology was demonstrated.

In the first solid-state camera system, a video signal was generated by sampling the charge voltages of the elements of the array directly in an *X* and *Y* (horizontal and vertical) scanning pattern. In the early 1970s, a major improvement was achieved with the development of the *charge-coupled device* (CCD), which was, in operation, a charge-transfer system. The photosensitive action of a simple photodiode was combined in one component with the charge-transfer function and metal-oxide capacitor storage capability of the CCD. The photo-generated charges were transferred to metal-oxide semiconductor (MOS) capacitors in the CCD and stored for subsequent readout as signals corresponding to pixels.

Thus, rather than directly sampling the instantaneous charge on each photosensitive picture element, the charges were stored for readout either as a series of picture scanning lines in the *interline-transfer* system or as image fields in the *frame-transfer* system. The basic concepts of each approach are shown in Figure 5.

The early CCD chips were interline-transfer devices in which vertical columns of photosensitive picture elements were alternated with vertical columns of sampling gates. The gates, in turn, fed registers to store the individual pixel charges. The vertical storage registers then were sampled one line at a time in a horizontal and vertical scanning pattern to provide an output video signal. This approach was

Courtesy of WNED-TV

Film chains, such as the one shown here, were commonplace 30 years ago. Today, a TV station may have only one, and seldom use it. This photo of a portion of the WNED-TV, Buffalo, NY, master control room was taken in 1960. The station's Ampex VR-1000B tape machine can be seen in the background.

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Milestones in the development of CCD devices for professional applications include Bosch's 1979 introduction of the FDL-60 CCD-based telecine, NEC's SPC-3 CCD camera in 1983, and RCA's CCD-1 camera in 1984.

Image reproduction

From the start of commercial television in the 1940s until the emergence of color as the dominant programming medium in the mid-1960s, virtually all receivers were the direct-view monochrome type. A few large-screen projection receivers were produced, primarily for viewing in public places by small audiences. Initially, the screen sizes were 10- to 12-inches diagonal.

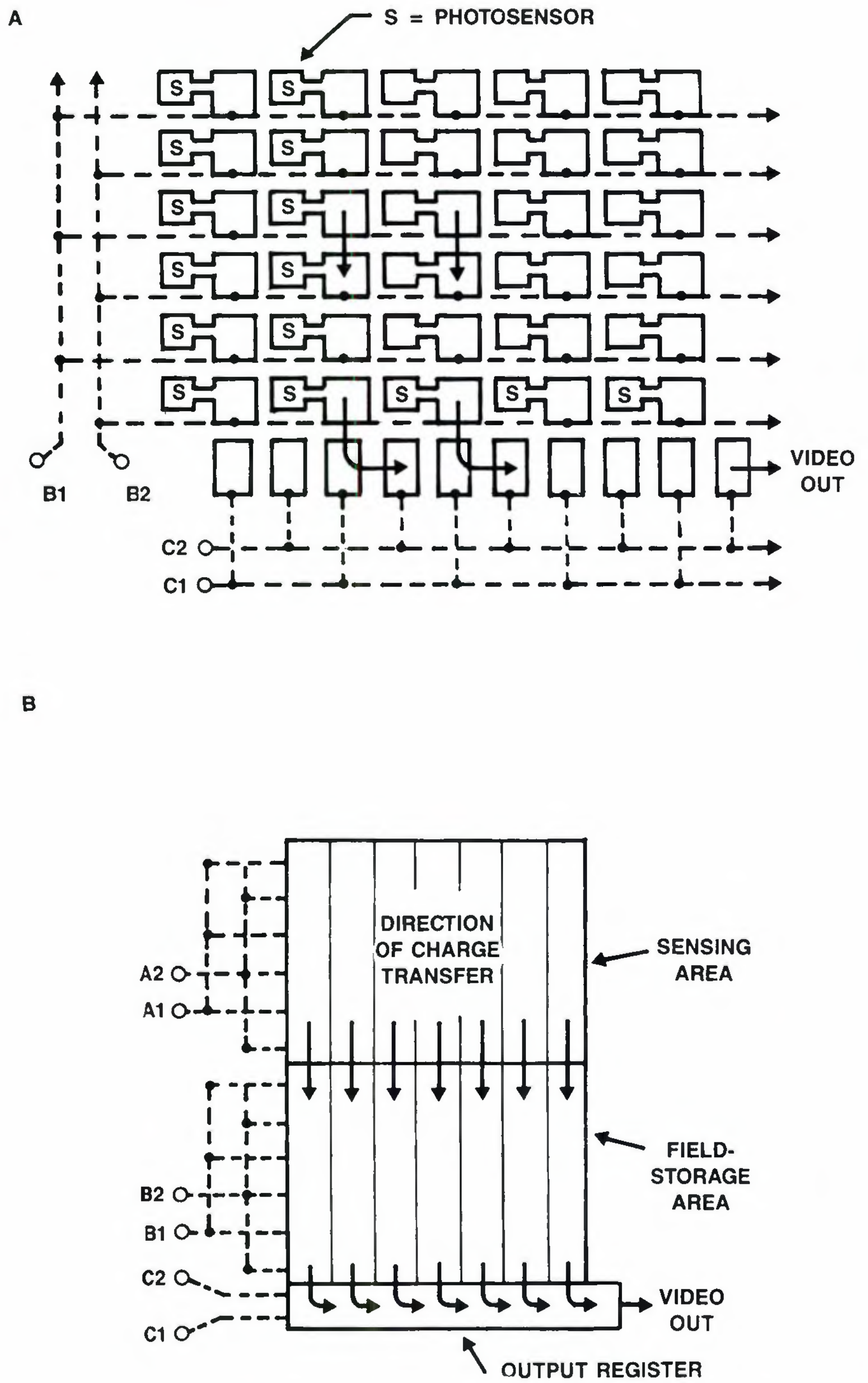

Figure 5. *CCD imaging architectures: (a) interline-transfer structure and (b) frame-transfer structure.*

The horizontal lines of the two fields on a receiver or monitor screen are produced by a scanning electron beam which, upon striking the back of the picture tube screen, causes the phosphor to glow. The density of the beam, and the resultant brightness of the screen, is controlled by the voltage level of a video signal applied between the controlling aperture and the cathode in the electron gun.

In the old days, viewers were advised to sit at least one foot away from the screen for every inch of screen size as measured diagonally. Thus, if you had a 25-inch-screen TV set, you were supposed to sit 25 feet away. In those early days the electron beam scan of the CRT phosphor revealed with crisp sharpness the individual scanning lines in the raster. In fact, the focus of the electron beam was sometimes purposely set for a soft focus so the scan lines were not as easily seen.

All color TV picture displays synthesize the reproduction of a color picture by generating light, point by point, from three fluorescent phosphors, each of a different color. This is called an *additive* system. The chroma characteristic, or hue, of each color light source is defined as a primary color. The most useful range of reproduced colors is obtained from the use of three primaries with hues of red, green and blue (RGB). A combination of the proper intensities of red, green and blue light will be perceived by the viewer as white.

Using this phenomenon of physics, color TV signals were first produced by optically combining the images from three color tubes, one for each of the red, green and blue primary transmitted colors. This early *Trinescope*, as it was called by RCA, demonstrated the feasibility of color television. The approach was, however, too cumbersome and costly to be a practical solution for viewing in the home.

The problem was solved by the invention of the shadow-mask picture tube in 1953. The first successful tube used a triad assembly of electron guns to produce three beams that scanned a screen composed of groups of red, green and blue phosphor dots. The dots were small enough that they were not perceived as individual light sources at normal viewing distances. Directly behind the screen, a metal mask perforated with small holes approximately the size of each dot triad was aligned so that each hole was behind an RGB dot cluster.

The three beams were aligned by *purity* magnetic fields so that the mask *shadowed* the green and blue dots from the beam driven by the red signal. Similarly, the mask shadowed the red and blue dots from the green beam, and the red and green dots from the blue beam. Figure 6

Continued on page 116

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SONY®

PROFESSIONAL VIDEO

Continued from page 112
depicts the principal elements of the shadow-mask tube.

Who was first?

The technology of television actually was the creation of many people in many countries over many years. It is correctly viewed as an international invention.

The Germans claimed to have begun broadcasting television to public audiences in 1935. The Farnsworth system was used in Germany to broadcast the 1936 Olympics at Berlin. The English also claim to have begun TV broadcasting through the facilities of the BBC in 1935. There were few receivers, however, in either country; most were in public gathering places, where they could be watched by many.

The United States did not come on-line with a broadcast system that sought to inform or entertain audiences until shortly before World War II. Although both Farnsworth and Zworykin had transmitters in place and operational early in their experiments, whatever programming was present was incidental. The main purpose was to experiment with the new communication medium. The goal at the time was to improve the picture being transmitted until it compared reasonably well to the 35mm photographic images available in motion-picture theaters. (We still are trying to accomplish that task today with HDTV!) There were, however, some pioneer TV broadcasters during the 1930s that offered entertainment and information programs to the few people who had TV receivers.

In 1933, TV station W9XK and radio station WSUI, broadcasting from the campus of the State University of Iowa, thrilled select Midwesterners with a regular evening program of television. WSUI broadcast the audio portion on its assigned frequency of 880kHz, and W9XK transmitted the video at 2.05MHz with a power of 100W. This twice-per-week program, the beginning of educational television, included performances by students and faculty with brief skits, lectures and musical selections. During the early 1930s, W9XK was the only TV station in the world located on a university campus, transmitting simultaneous video and audio programs.

TV grows up

Both NBC and CBS took early leads in paving the way for commercial television. NBC, through the visionary approach of David Sarnoff and the resources of RCA, stood ready to undertake pioneering efforts to advance the new technology. Sarnoff accurately reasoned that television could establish an industrywide dominance only if TV set manufacturers and broadcasters were using the same standards. He knew this would occur only if the FCC adopted suitable standards and allocated the needed frequency spectrum. Toward this end, in April 1935, Sarnoff made a dramatic announcement that RCA would put millions of dollars into TV development. One year later, RCA began field testing TV transmission methods from a transmitter atop the Empire State Building.

In a parallel move, CBS (after several years of deliberation) was ready to make its views public. In 1937, the company announced a $2 million experimental program that consisted of field testing various TV systems. It is interesting to note that many years earlier, in 1931, CBS put an experimental TV station on the air in New York City and transmitted programs for more than a year before becoming disillusioned with the commercial aspects of the new medium.

The Allen B. DuMont Laboratories also made significant contributions to early television. Although DuMont is best known for CRT development and synchronization techniques, the company's major historical contribution was its production of early electronic TV sets for the public beginning in 1939.

It was during the 1939 World's Fair in New York and the Golden Gate International Exposition in San Francisco the same year that exhibits of live and filmed television were demonstrated on a large scale for the first time. Franklin D. Roosevelt's World's Fair speech (April 30, 1939) marked the first use of television by a U.S. president. The public was fascinated by the new technology.

TV sets were available for sale at RCA's pavilion at the World's Fair. Prices ranged from $200 to $600. Screen sizes ranged

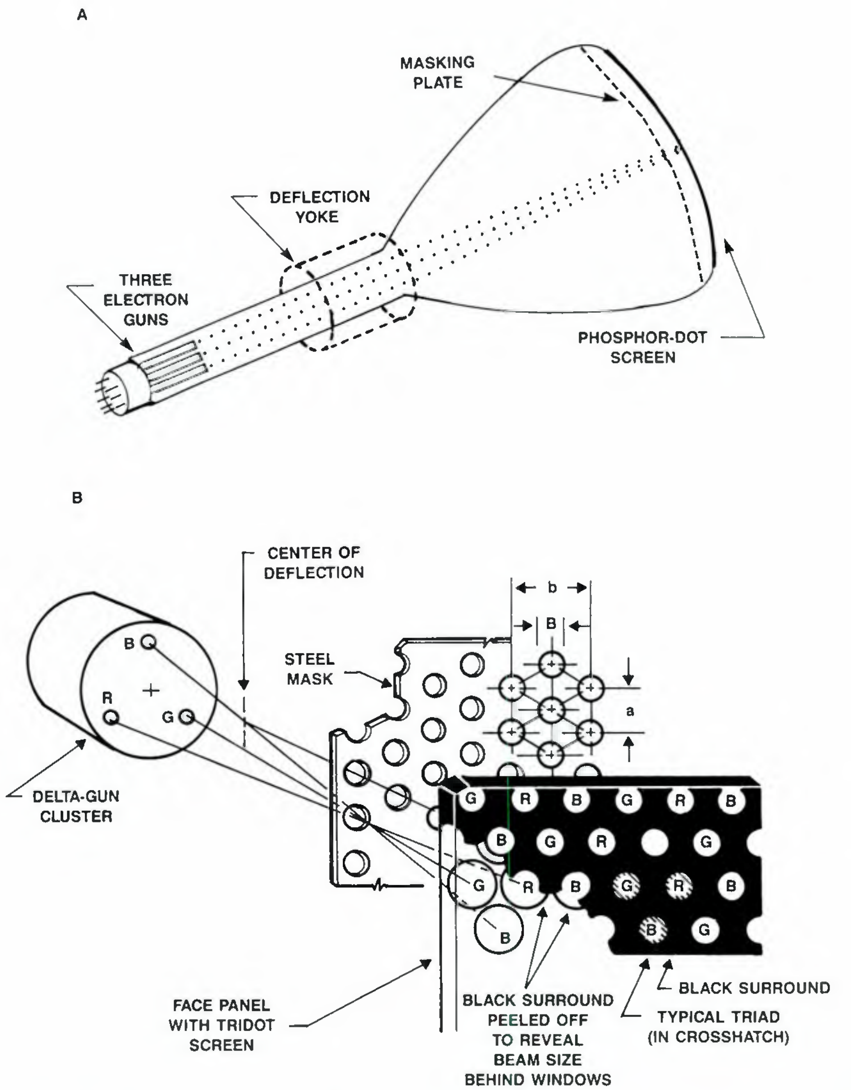

Figure 6. *Principal elements of the delta gun, round-hole mask, negative guard band tri-dot CRT. (a) Overall schematic of the shadow-mask tube. (b) Enlarged section (not to scale) of a triad gun assembly showing the geometric relationships of the electron beams, the masking plate and the phosphor dots on the glass faceplate.*

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from five inches to the "big-screen" model of 12 inches. Because CRT technology at that time did not permit wide deflection angles, the picture tubes were long. So long, in fact, that the devices were mounted (in the larger-sized models) vertically. A hinge-mounted mirror at the top of the receiver cabinet permitted viewing.

At the San Francisco Exposition, RCA had another large exhibit that featured live television. The models used in the demonstrations could stand the hot lights for only a limited period. The studio areas were small, hot and suitable only for interviews and commentary. People were allowed to walk through the TV studio and stand in front of the camera for a few seconds. Friends and family members were able to watch on monitors outside the booth. It was great fun, the lines were always long and the crowds enthusiastic. The interest caused by these first mass demonstrations of television sparked a keen interest in the commercial potential of TV broadcasting. Both expositions ran for a second season in 1940, but the war had started in Europe, and TV development was about to grind to a halt.

Television was formally launched in July 1941 when the FCC authorized the first two commercial TV stations to be constructed in the United States. However, the growth of early television was ended by the licensing freeze that accompanied World War II. By the end of 1945 there were just nine authorized commercial TV stations, with six of them on the air. The first post-war full-service commercial license was issued to WNBW, the NBC-owned station in Washington, DC.

As the number of TV stations on the air began to grow, the newest status symbol for Americans became a TV antenna on the roof. Sets were expensive and not always reliable. Sometimes there was a waiting list to get one. Nobody cared, it was all very exciting — pictures through the air. People would stand in front of a department store window just to watch a test pattern.

Courtesy of PBS

The technical facilities of stations and television networks are built today not only for efficient operation, but also for attractive appearance. Walnut-grain cabinets and desks, carpeting, custom equipment racks and dramatic task lighting characterize modern facilities. Contrast this photo, which shows a portion of the new PBS technical center in Washington, DC, with the 1960 WNED-TV photo.

Producing and transmitting color television was no small feat in the early 1960s. Shown is a local station studio in 1964. Note the RCA camera.

Continued on page 122

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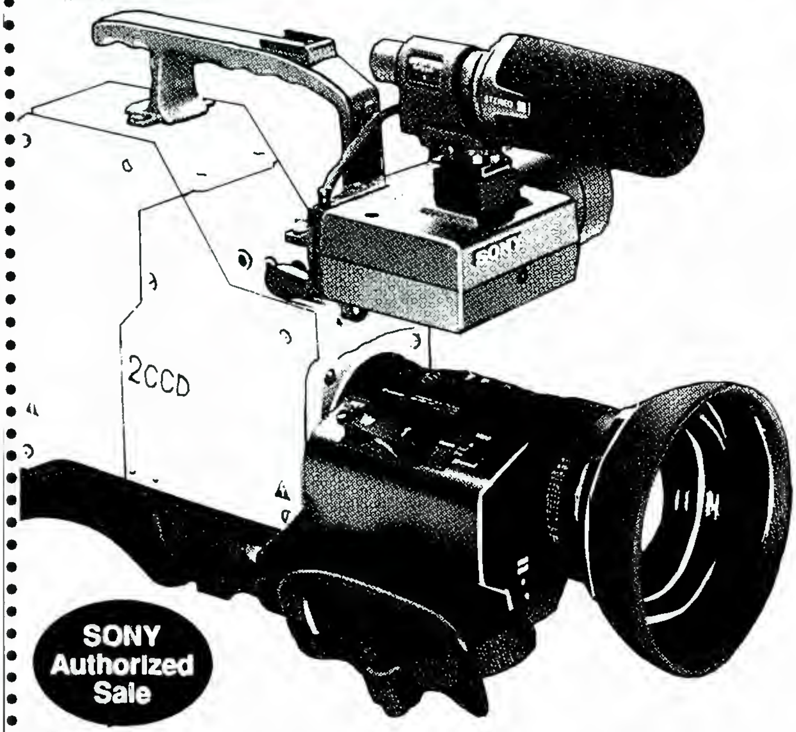

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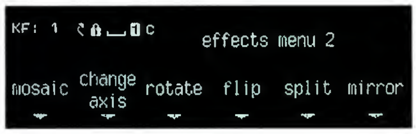

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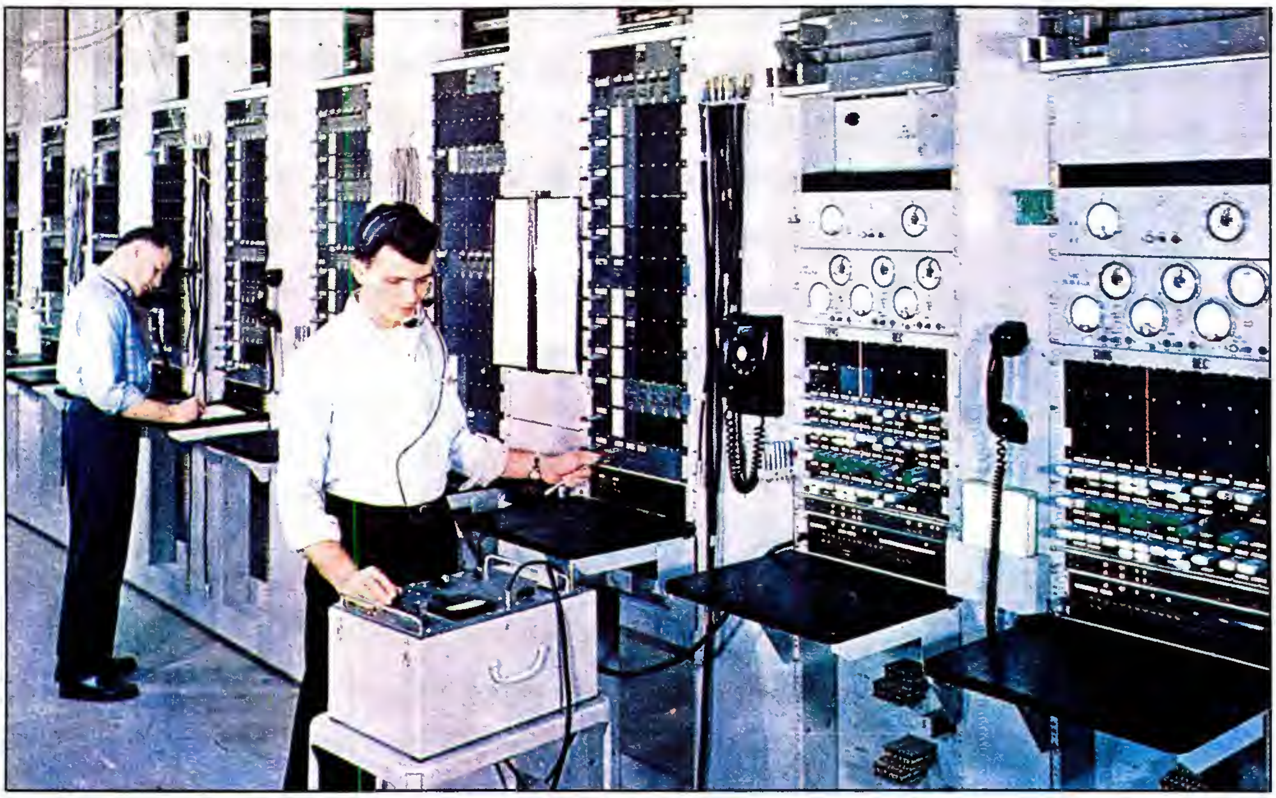
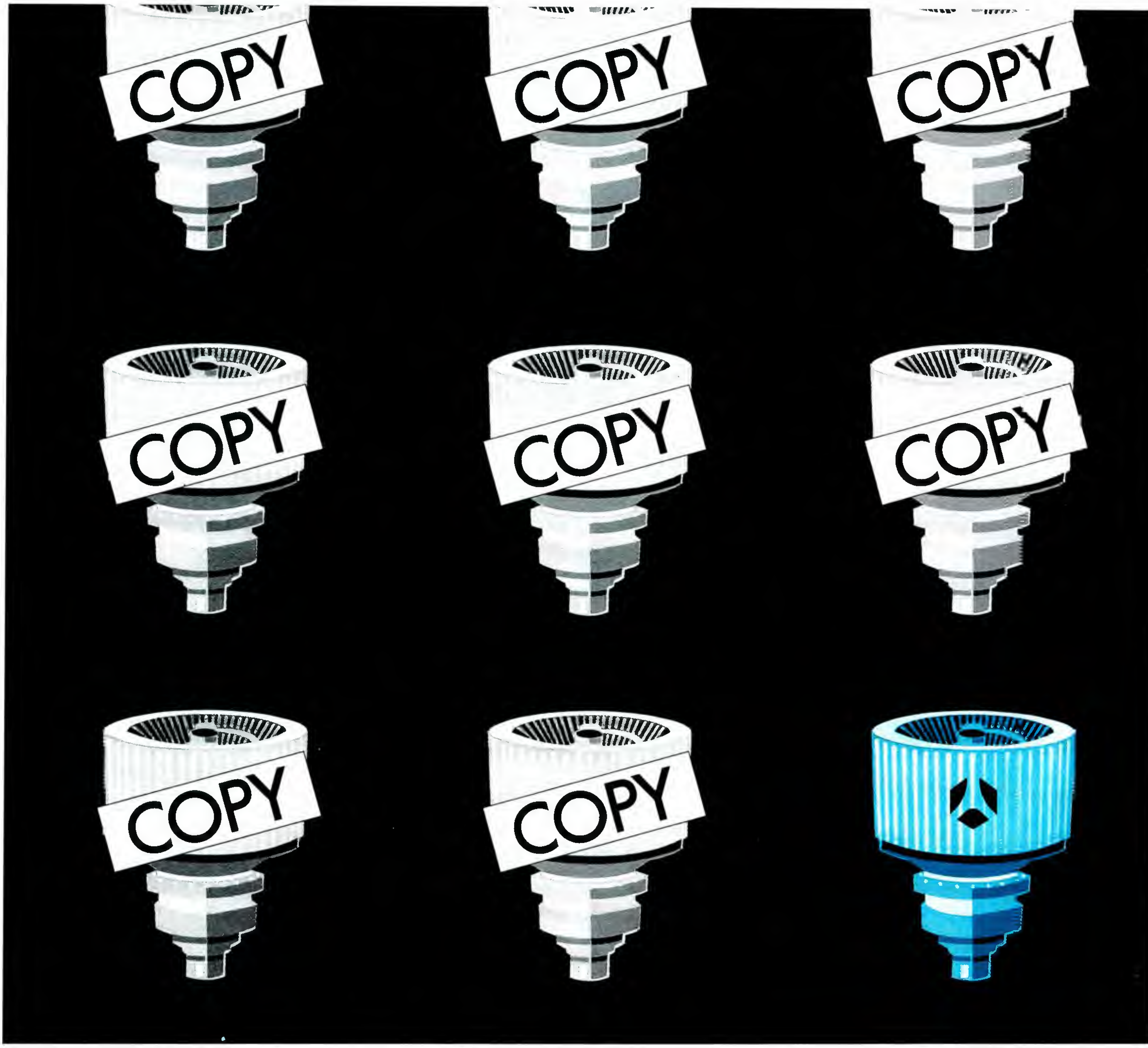
Continued from page 118



"It's leaving here OK." From the beginning of television until the early 1980s, network TV was intimately tied to the facilities of AT&T and the local telephone companies. All that changed, however, with the development of satellite distribution.



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POLARIS EXPANSION US. 1

NTSC makes its appearance

In 1948, the FCC imposed a freeze on TV grants pending a complete review of the allocation system. For about three years, no new applications were filed. However, during this time the industry was not idle, and the National Television System Committee (NTSC), composed of engineers from all the major and some of the minor electronics companies, was engaged in developing a color TV system.

The basic requirements were high quality and compatibility with the existing monochrome system. The committee's work was lengthy and detailed. Some engineers on the project even were tested for color blindness to ensure that all saw the same color at the same time. Various slides were used for test purposes with different types of encoding and decoding hardware.

Meanwhile, CBS had been pushing its color filter wheel (whirling disc) system. In a move that surprised most of the broadcast industry, the commission approved the whirling disc as the standard color transmission system in October 1950. The system was, unfortunately, not compatible with present black-and-white receivers — there were an estimated 10 to 15 million of them at the time — and performance of the mechanically based system left something to be desired. Three years later (Dec. 17, 1953) the commission reversed itself and voted in the NTSC system still in use today.

With FCC approval, work on converting existing products to color began to move ahead. It would be more than a decade, however, before most consumers would be able to enjoy the fruits of the NTSC labors. Early problems caused somewhat unusual changes in the color of the received picture. These problems led, of course, to the well-known description of our NTSC color system: *Never twice the same color.*

In France, Germany and other countries, engineers were hard at work trying to improve upon our system. France developed the SECAM (sequential couleurs a memoir) system, and Germany produced the PAL (phase alternating lines) system. Proponents of these three systems still debate their advantages today.

Outside broadcast work has always been an important element in television. Thankfully, the means to accomplish this end have changed dramatically over the years. This remote pickup by WPIX-TV, New York, took place in August 1964.

They don't do remotes like they used to. And that's a good thing! This 1964 vintage mobile van is a far cry from the ENG units on the streets today. Note the "portable" camera.

UHF comes of age

The early planners of the U.S. TV system thought that 13 channels would more than suffice for a given society. The original channel 1 was from 44MHz to 50MHz, but was later dropped before any active use because of possible interference with other services. There remained 12 channels for normal use.

Bowing to pressure from various groups, the FCC revised its allocation table in 1952 to permit UHF TV broadcasting for the first time. The new band was not, however, a bed of roses. Many people went bankrupt building UHF stations because so few receivers were available to the public. UHF converters soon became popular. The first converters were so-called matchbox types that were good for one channel only. More expensive models mounted on top of the TV receiver and were tunable.

Finally, the commission issued an edict

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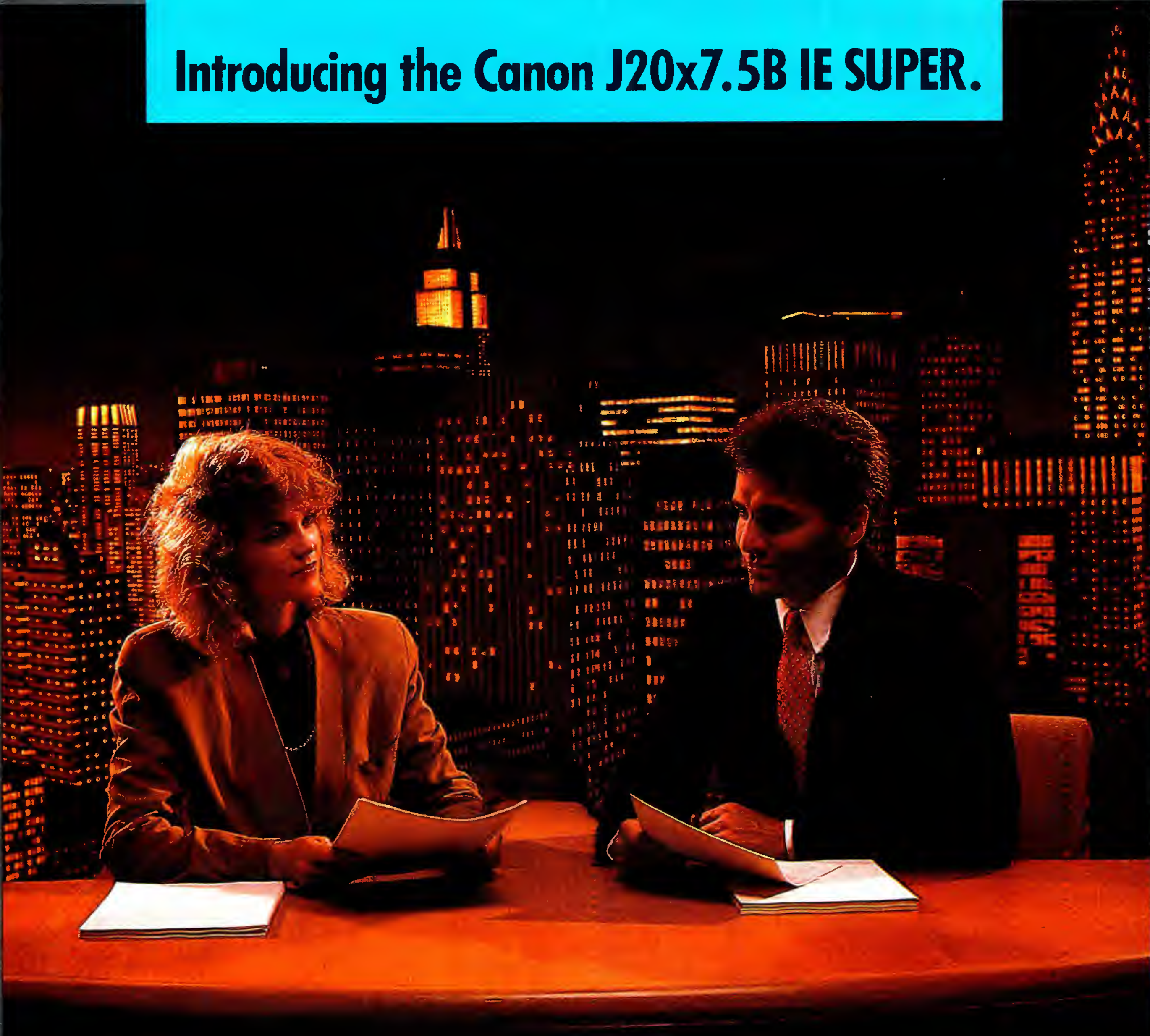

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that all TV set manufacturers had to include UHF tuning in their receivers. This move opened the doors for significant market penetration for UHF broadcasters. Without that mandate, UHF broadcasting might still be in the dark ages.

Courtesy of Centro

Remote production today is not unlike production at the studio. Large, complex trailers have given field producers the capability to take the tools of the trade on the road. Shown is the interior of an NBC-TV tape production van.

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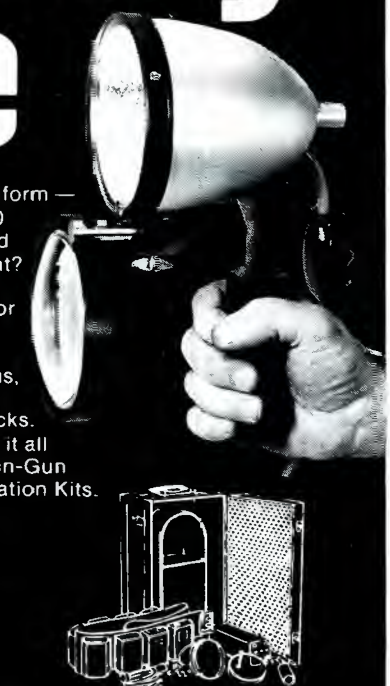

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SMPTE IMD	YES	NO	YES	YES
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Transient IMD	YES	NO	NO	NO
Wow & flutter	YES	NO	YES[1]	NO
Phase measurement	YES	NO	YES	NO
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[1] *Announced, no specifications available*
[2] *Personal computer. Interface card included in instrument price.*
[3] *H-P Model 310M IEEE-488 compatible*
[4] *Personal computer plus IEEE-488 interface card*
[5] *Tektronix MP2902 system consisting of instruments, software, Tek 4041/4205 IEEE-488 controller*
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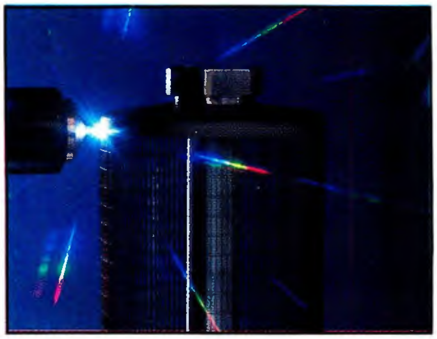

Surround sound for television

By Dennis R. Ciapura

The motion-picture industry has discovered the value of *surround sound* for enhancing the visual experience. High-performance audio has become a prime promotional thrust. If you have been fortunate enough to view a recent film in a theater equipped with a good stereo surround audio installation, such as Lucasfilm's THX system, you can understand why. Surround sound truly adds a whole new dimension to the audio presentation, and most first-run theaters already are equipped with the capability. Nearly 2,000 films have been produced with surround, and the public is becoming accustomed to having this feature in the theater environment.

Surround sound poses a challenge for television because it further differentiates the tube from the big screen. Although we may have to wait for HDTV and its higher resolution and a modern aspect ratio, surround sound is easy and inexpensive to implement at MTS-equipped TV stations. Because the surround signal is embedded in the conventional stereo channels, no additional audio switching, distribution or transmission is required.

Surround sound is part of the standard Dolby film process, and it was made possible by the use of two high-fidelity optical channels for stereo films. With optical recording, there is a trade-off between narrow photocell gap width for extended highs, and the resulting degradation in signal-to-noise ratio. Dynamic range is a critical parameter for film.

In 1938 a standard monitoring curve was established to ensure that studios and theaters worked to the same standard. That curve, shown in Figure 1, became known as the "academy curve." Previously, studios used different high-frequency rolloffs to combat the optical noise revealed by modern speakers. Most of what we heard in theaters was, at best, 8kHz response.

Since 1972, Dolby films have used the curve shown in Figure 2. The curve specifies a rolloff of 3dB per octave above 2kHz, when the theater is measured with pink noise. The test procedure includes both the direct signal from the loudspeaker and the reverberation component from the auditorium. The result produces an approximate 1dB- to 1.5dB-per-octave rolloff above 2kHz. Subjectively, this means that the response is down about 3dB to 4dB at 10kHz.

The application of the Dolby A noise reduction dramatically widened the performance envelope for film. Today's stereo optical systems typically produce 12kHz response with more than 70dB of dynamic range.

Beyond stereo

The introduction of a second audio track allowed the surround signal to be matrixed on the two tracks. A special Dolby Motion Picture (MP) matrix was used to develop the signal. It is important to understand that the MP matrix was quite different from the quad SQ and QS encoding that was promoted in the 1970s.

Any multichannel-matrix encoding scheme necessarily embodies some compromise between front-to-back and left-to-right separation. The encoding developed for records and radio was designed to pro-

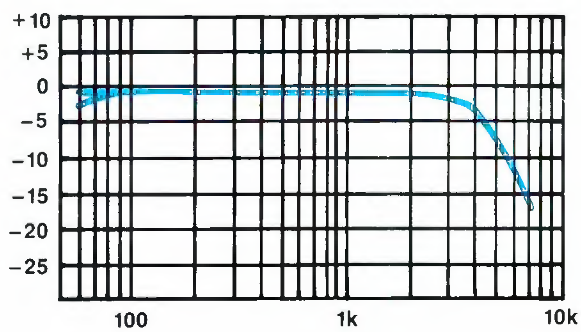

Figure 1. The original "academy curve" helped establish a uniform response standard for both movie companies and theaters.

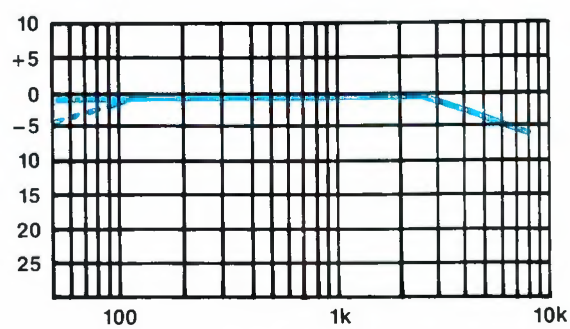

Figure 2. The "X" curve has been used by Dolby films since 1972. The result is a relatively flat response to about 10kHz.

Ciapura is vice president, technical operations, for Noble Broadcast Group, and president of TEKNIMAX Telecommunications, a San Diego-based technical management consulting company.

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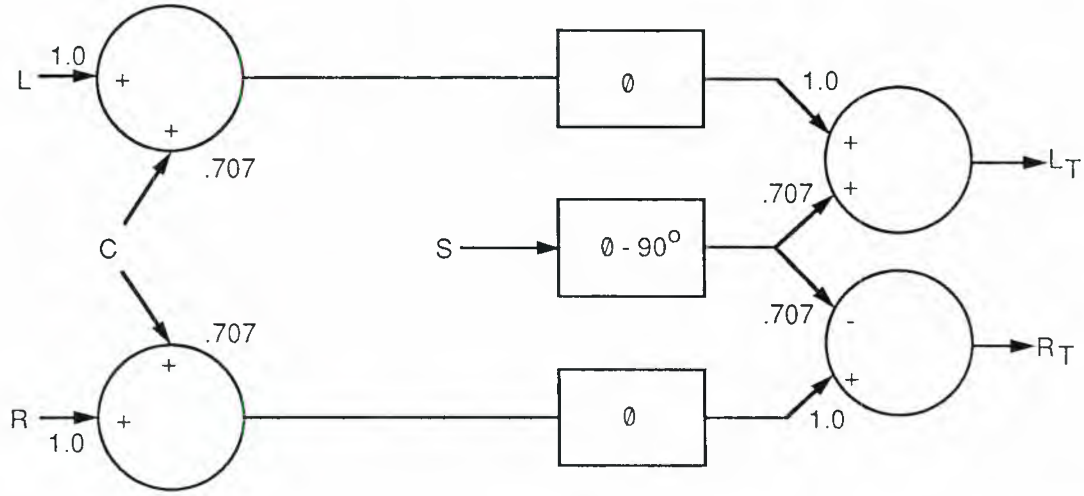

Figure 4. *The basic surround encoding process is simple. The two input channels are inverted and added back to the original audio by a dynamic matrix.*

room itself. Level shifts alone won't do it because the difference signal also is present at a tracking amplitude in the front speakers, although out of phase. A 90° shift places the image in the center of the room.

Other enhancements in the more advanced decoders are related to improving the positioning accuracy through the use of a *dynamic matrix*. When a highly directional signal is sensed, the matrix parameters are altered to minimize leakage into the opposite channel. The overall power in the matrix is always the same. Therefore, unlike gain-riding steering schemes that modulate levels, the dynamic matrix approach does not generate audible level shifts. The simplified block diagram of a typical decoder is shown in Figure 5.

Broadcast concerns and applications

Any TV station that is operating in stereo is already in the surround sound business. The majority of recent films on stereo network feeds already contain surround encoding. In fact, there's no way to remove it (short of going mono) even if you wanted to. Stereo music programming also generates considerable ambient effects in the surround in proportion to the L–R content.

This is an asset as well as a liability for the MTS-equipped station. Viewers with surround equipment give the station credit for providing the special effects, but the station also risks irritating viewers considerably if the surround is distorted. Unfortunately, many stations are unwittingly doing just that.

When the stereo MTS signal is monitored in a conventional 2-channel stereo mode, the L–R component is barely audible. This is because it is embedded in a much stronger L+R base. Even stereo music without dialogue is more mono than stereo because the performance focus is almost always distributed around the center position. Therefore, the pure L–R surround signal is largely masked by the front-channel content. However, in TV sets with stereo surround, the entire L–R content is reproduced at full level by itself in the surround speakers. Any impairment of the L–R is quite audible. Unfortunately, many TV engineers don't realize how awful spurious L–R can sound because they can't hear the problem using conventional stereo monitors.

The most common problems affecting surround sound were discussed in "Stereo TV Grows Up" (see page 52 in the August 1988 issue). They included tape deck phase shift from head misalignment, use of stereo synthesizers and differential distortion. The bottom line is that anything that generates spurious L–R generates spurious surround signals. Unfortunately, spurious L–R can be produced by stereo synthesizers. With a reverb-type synthesizer, the resulting L–R may be so obnoxious in the surround that the encoder must be turned off.

Tape deck misalignment causes phase shift that increases as a function of frequency and is most audible on speech sibilants. The resulting L–R audio shifts to the surround speakers, creating unwanted surround sound.

Differential distortion is probably the least understood phenomenon. It is distortion that affects once stereo channel differently than it affects the other. For example,

Use of surround sound at a baseball game. Two microphones in parabolic dish mounts provide detail audio. One microphone is aimed at the batter's box to capture the bat cracks of right-handed batters. The other microphone is aimed at first base. A similar arrangement is used on the third-base side.

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if the safety clippers in the audio limiters do not clip at exactly the same threshold, the difference signal becomes L−R audio (grossly distorted L−R). Overdriven DAs produce the same effect.

Incidental carrier phase modulation (ICPM) always was expected to be a significant MTS problem. Fortunately, many stations have found that their stations work just fine in stereo without any special ICPM reduction effort. However, because ICPM primarily affects the L−R, it's the surround that suffers most. In some cases, high ICPM has been traced to exciter non-linearity rather than transmitter and antenna limitations. This is a little surprising because low-level equipment is expected to have a wide and flat response.

Effective monitoring is the solution

Most of the problems affecting the surround go undetected simply because of a lack of effective monitoring. Every MTS-equipped station should have a surround decoder for the control room audio monitor, engineering office monitor, or preferably both. The equipment is inexpensive. In addition, because the decoders are so sensitive to L−R problems, they actually help ensure optimum stereo performance as well.

Differential distortion, for example, may go unnoticed in a busy control room with only conventional stereo monitoring. However, it's quite obvious in the surround speakers. Having a sensitive L−R audio monitor (surround decoder) at the station provides an extra measure of audio quality control.

In addition to a plethora of consumer surround decoders and amplifiers with built-in decoders, there are at least two pro units designed for broadcast applications. The Dolby model SDU4 has balanced XLR inputs and outputs. It operates at normal +4dBm and +8dBm operating levels. The unit provides the option of a discrete center-channel output for monitoring systems with three front amplifiers and speakers. It also has the standard 2-channel front output for smaller systems. In either case, the correct levels are provided automatically by an internal selector switch. The unit also includes a built-in pink noise source that can be automatically or manually cycled around the channels to aid in initial alignment and routine operational checks. Front-panel selection of mono, stereo or surround monitoring makes this unit easy to use as a control room or audio monitor for engineering.

Shure has developed a line of professional and consumer surround products under the *Stereosurround* banner. The pro line features an encoder, decoder, and interchannel delay corrector designed for surround applications. The units have balanced XLR inputs and outputs, work at professional levels and provide control flexibility.

Active surround operations

The Shure HTS100SE encoder offers the opportunity to originate surround programming in addition to passively airing encoded sources. The unit features front-panel VU meters, which can be set to either +4dBm or +8dBm reference level; input trimmers for L, C, R, S and pan; output trimmers for L_T and R_T; and pan pots for L/R and F/S. It can function as the heart of either a live stereo surround remote-broadcast kit, or in a post-production application for taped programs. This year's CBS Grammy Awards broadcast was produced in Shure Stereosurround, as are the WGN-TV Chicago Cubs home games. Shure says these games were the first regularly scheduled telecasts in stereo surround.

Dolby makes its SEU4 surround encoder available to broadcasters and video producers on a lease basis. This is similar to the arrangement film producers use. The company assists with setup, applications engineering and training of operating personnel. Several episodes of "Amazing Stories," "The Tonight Show," "The David Letterman Show" and various sporting events have been produced in Dolby surround, and more are on the way.

The most natural and early application of stereo surround for television has been to reproduce ambient sounds, such as a live audience. Today, post-production insertion of surround effects along with stereo music beds are becoming routine. In the studio, the key to maintaining solid localization is to rely on panned mono recording techniques.

This is particularly true for dialogue that must be centered firmly on the screen. Trying to reproduce a conversation between two or more people using stereo microphone techniques will generate excessive L−R and sound extremely hollow on surround-equipped receivers. Pinning a lavalier on everybody and using pan pots to position each person is a better approach. Ambient effects may be handled in stereo.

There is one specialized application for stereo mics that is ideal for television. On ENG remotes, a simple hand-held M-S (mid-side) stereo mic provides a lot of versatility. The M-S configuration allows feeding the L+R and L−R capsule outputs to two audio tracks. Because the ENG talent normally works the microphone closely, the L+R output remains dominant. The ratio of L+R to L−R can be mixed as desired in post-production. This allows you to adjust the ambience, providing a stereo and surround feel with the announcer's voice well-centered.

Trend or toy?

In light of the failure of quad in recording and radio applications, you might reasonably question the long-term viability of surround for television. Is it likely to become standard TV broadcast practice

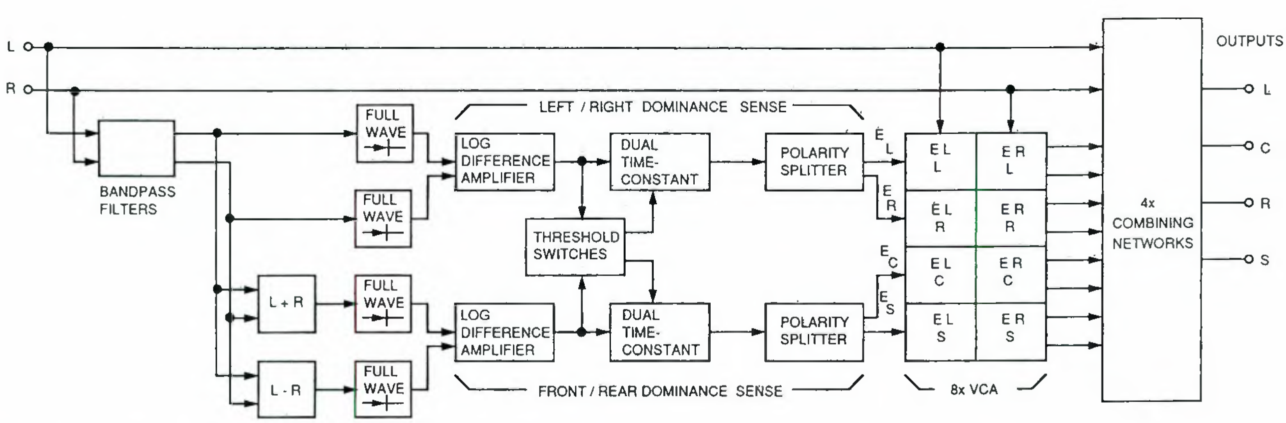

Figure 5. *Simplified block diagram of a Dolby surround decoder.*

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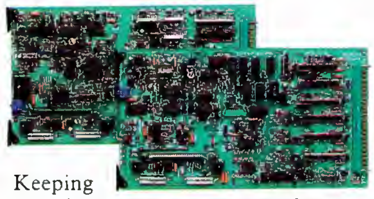

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One of two suspended microphones used as primary crowd noise pickups for a baseball game.

or will it survive only as a videophile toy? A key difference between quad and TV surround is that surround is already well-established as a standard technique in the film industry. In addition, consumer interest and acceptance seem high.

More than 300,000 Dolby surround decoders were sold worldwide in the last quarter of 1988 alone, up from 125,000 in the first quarter. An interesting note is that 56% of the decoders are going into complete televisions as opposed to add-on applications. This means that the decoders are going to mainstream consumers and not just videophiles.

At this point, there seems to be little doubt that surround will continue to grow and become a standard feature on most monitor and console receivers.

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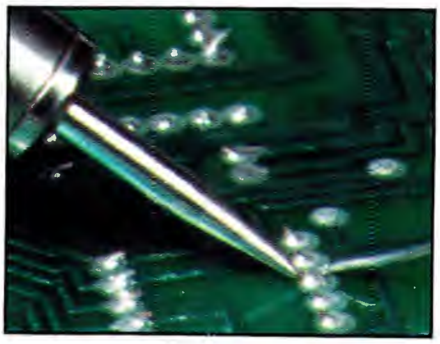
Spare parts shortage leads to innovation



By David L. LLoyd

Maintaining any piece of electronic equipment can be quite challenging, but maintaining equipment without spare parts is next to impossible. This is the task we faced with the Ohio Educational Broadcasting Intercity Microwave System.

The system is a statewide, duplex video microwave network operating in the 2GHz, 7GHz, 13GHz bands and covering some 2,200 channel miles. The network is used to distribute more than 36,000 hours annually of educational programs to 12 public TV stations and several universities throughout Ohio. The system operates 24 hours a day, 365 days a year.

The original microwave system was designed and installed by ITT Federal Electric Corporation and has been maintained by the company since 1975. The system is configured with a combination of 78 Harris/Farinon model FV2F, FV7F and FV13F video microwave transmitter/receiver pairs.

Problems develop

The saga began with several failures of like components in a month's time, depleting our spares stock for the model FV7F and FV13F radios. To add to the problem, defective parts started coming back from the factory as unrepairable due to lack of third-party vendor support, which is not uncommon with old equipment. What really compounded the problem was that the two most critical units, the voltage-controlled oscillator (VCO) and the RF output stage injection-locked amplifier (ILA) were obsolete and could not be purchased from the factory.

Because of the immediate need for spare parts for continued operation, we chose to modify the existing radios by using factory parts that were readily available. This meant using components designed for the original 7GHz and 13GHz radios that were designed for a new model.

IF stage modification

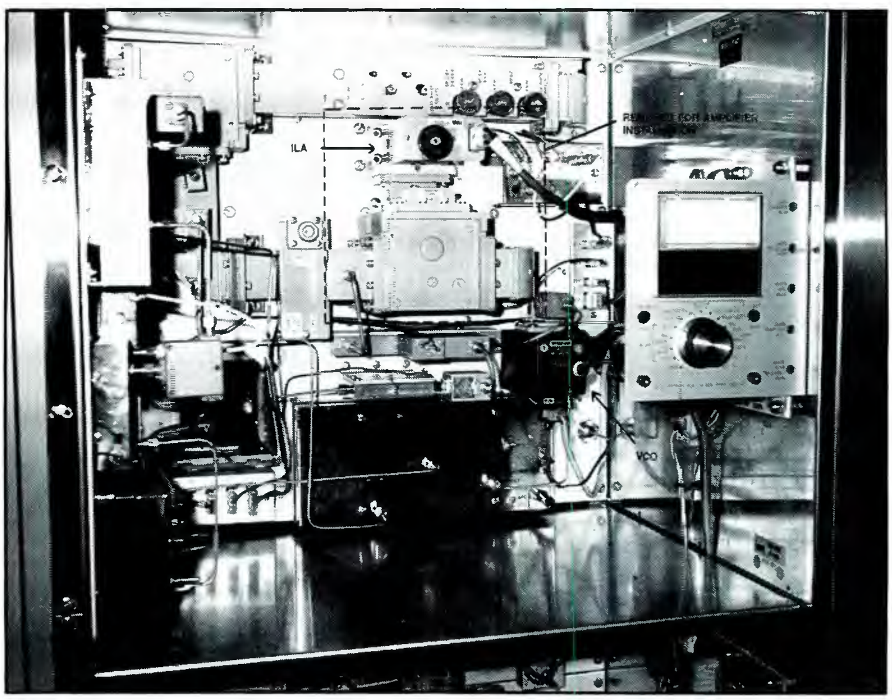
Our first approach was to modify a dual-conversion model FV7F, which used 70MHz and 1,470MHz IFs, to emulate a new single-conversion product radio. This solution was quite involved and required a total radio modification when only a VCO or ILA was needed. However, because we had parts available for the single-conversion from a new installation radio, we went ahead with a prototype.

A portable model FV7P radio was used to maintain service while the model FV7F radio was being modified. The internal waveguide plumbing required extensive reworking to accommodate the new, larger ILA and upconverter. A ¾-inch hole was drilled through the backplane of the radio frame to accommodate the ILA's heatsink rod. A new, higher output power phase source was side-mounted and connected to the upconverter by an SMA flexible cable. An RF bandpass filter and one circulator were salvaged from an older-generation radio and used in the prototype. Only two small waveguide pieces and one offset plate had to be purchased.

As shown in Figure 1, the single-conversion radio is simpler in design than the dual-conversion type. The upconverter mixes the phase-lock source frequency (70MHz above or below the RF frequency) with the 70MHz IF from a modulator or receiver output. The resulting output RF frequency is then waveguide-coupled through a bandpass filter to the ILA. Here it is amplified to 1W and fed out to the antenna via the waveguide.

The design and new components in the converted radio allowed many original components to be removed and used as spare parts for other old radios. However, the cost of the new components to modify the FV7F radio was more than $8,900. But, because this did not include the cost of the new spare parts and labor considerations, it was not a cost-effective solution.

Another significant reason for not implementing this single-conversion modification was the RF-frequency plan. The greater receiver selectivity provided by the dual-conversion radio is required for some close frequency separations in our plan.



The original Farinon radio with obsolete ILA and VCO. The ILA, mode suppressor, U bend, two circulators and transducer are removed for installation of the new amplifier.

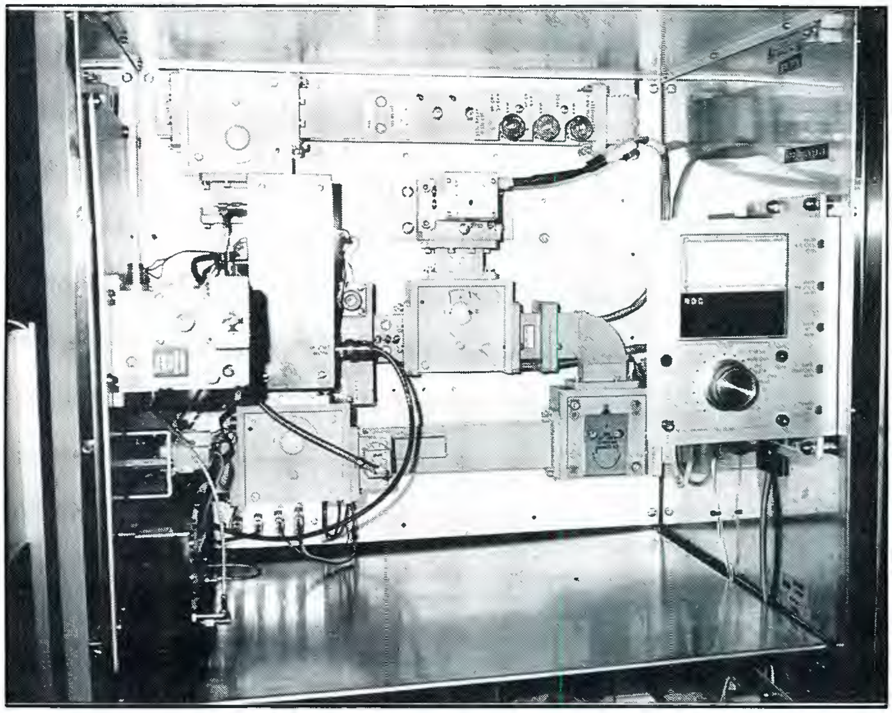
Lloyd is maintenance supervisor, ITT Federal Electric, Columbus, OH.

Alternative solution

These problems led us to an alternative approach. We chose to use direct replacements in the existing radio on a component-for-component basis. The replacements then would be completely compatible with the existing stringent performance parameters.

After contacting several component manufacturers and reviewing many specification sheets, we found a wideband, solid-state amplifier that could replace the ILA directly. Our input and output levels, impedance, bias power and space requirements were all met by the new amplifier. In fact, a deteriorating video frequency rolloff problem caused by the aging ILAs was corrected by the new amplifier. The new low-noise amplifier delivers a clean and flat video signal with improved RF-frequency stability. The amplifier consumes less than half the power of the old ILA and runs cooler.

The replacement ILA is a wideband, low-noise amplifier model AMF-3B-6871-30P, manufactured by Miteq Corporation. It sells for approximately $2,300. The VCO replacement with the required amplifier is model OTC-1CM-083-086-15P-AFC and is approximately $2,200.



The new ILA, upconverter and phase source in this single-conversion prototype replace all the mixers, amplifiers, VCO and AFC circuitry associated with the dual-conversion design.

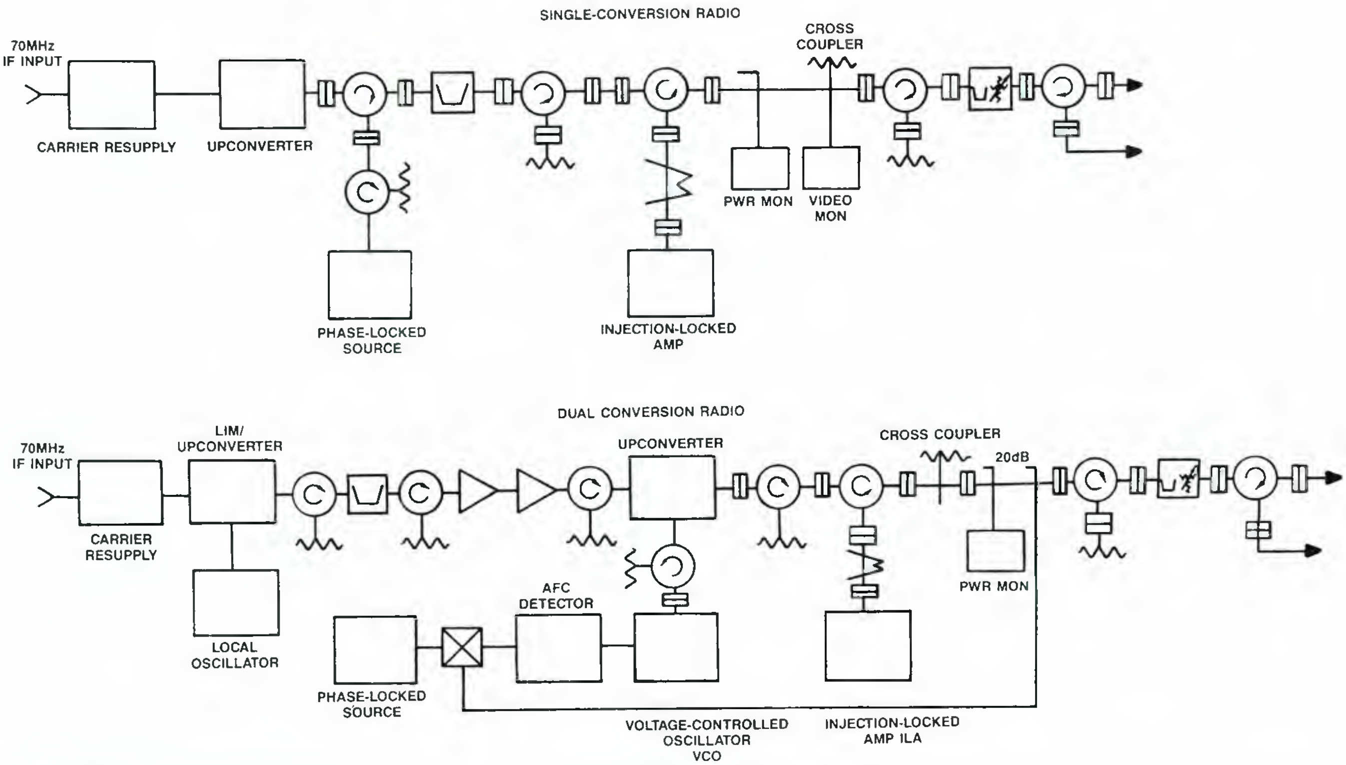
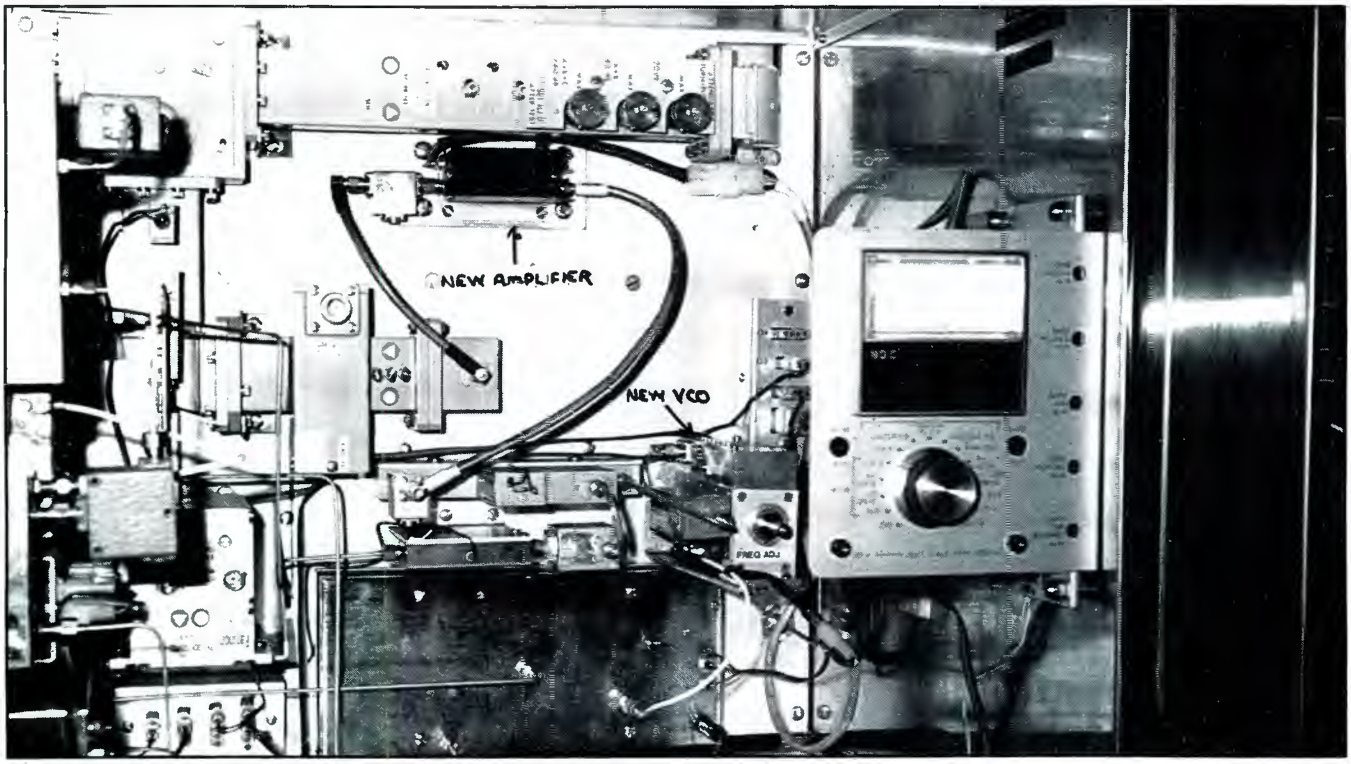


Figure 1. *The dual-conversion radio mixes the IF twice, once to create a high IF at 1,470MHz and again to obtain the 7GHz output RF frequency. The dual-conversion technique was kept for better frequency selectivity and frequency rejection.*



The replacement amplifier and VCO occupy but a small portion of the originally needed space. Because the components draw so little current, no power-supply changes are needed.

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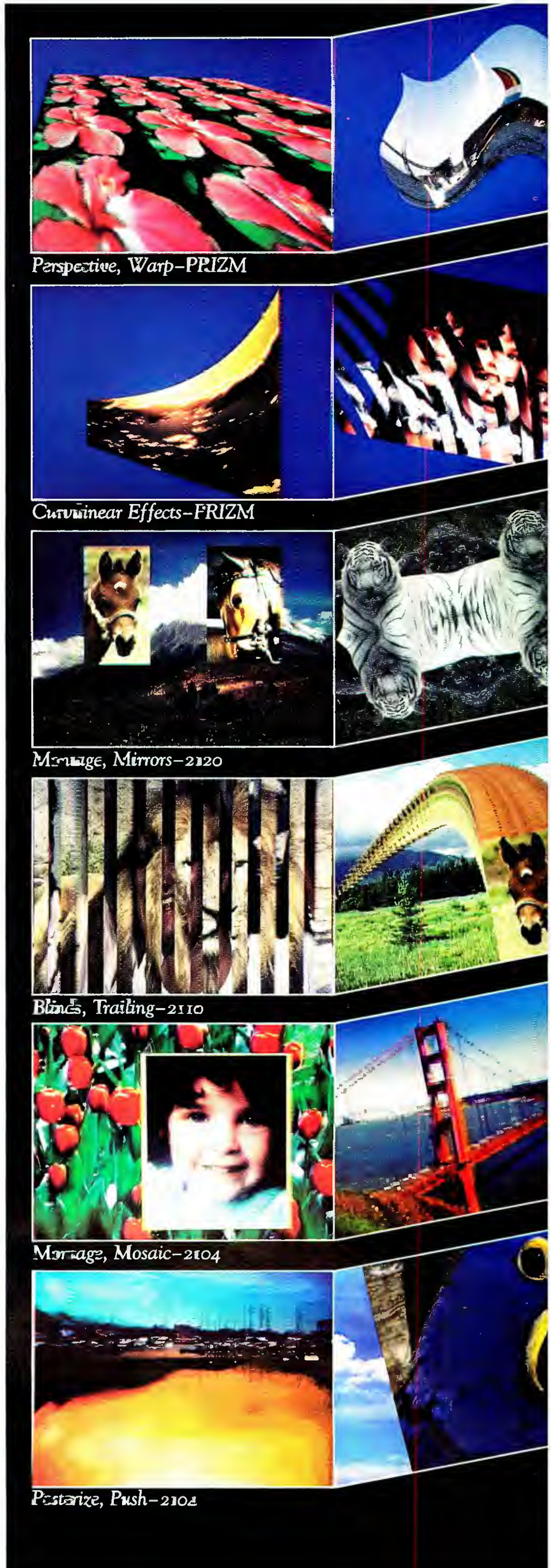

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Installation procedure

Installation of the new amplifier requires that the SMA-to-waveguide transducer, two large circulators, U bend, mode suppressor and ILA be removed in one piece. The SMA-to-waveguide transducer then is removed and attached to the cross-coupler input. The new amplifier is small enough to mount onto the old ILA heatsink spacer by drilling and tapping four No. 8-32 holes to accommodate the amplifier mounting holes. The amplifier then can be mounted easily to the radio backplane with the spacer already attached.

Two small isolators (SD-60460-002, purchased from Harris) with SMA connectors are attached to the upconverter output and to the amplifier output for matching and isolation purposes. Flexible cables of RG-142B were made to length for connecting the amplifier to the upconverter and waveguide. The voltage connection is a 0.093-inch 3-conductor jack that mates with the existing ILA voltage plug, providing a relatively easy installation. The bias voltage of the amplifier is +15Vdc, which is within range of the variable ILA bias adjustment on the existing power supply.

The second critical item, the VCO, is a standard off-the-shelf replacement unit. Because the new VCO's output level was not high enough, an amplifier was added to the VCO output port by the manufacturer. The amplifier increased the VCO output level to the required +23dBm. We fabricated a small L bracket to mount the new, longer and narrower VCO onto the radio backplane using the same holes the old VCO used.

The isolator from the old VCO attaches to the new unit and the output can be coupled to the upconverter by either a new SMA flex cable or by reforming the existing hardline coaxial cable. A flexible cable with an SMA connector on one end and pigtail wires on the other were used to connect the AFC detector output to the AFC input on the VCO. The AFC control voltage range for the VCO is −2Vdc to −19Vdc, which is identical to that of the old unit.

Voltage for the new VCO is also +15Vdc and is easily obtained by the front-panel VCO adjustment on the existing power supply. The voltage connections are made by a 0.062-inch 3-conductor jack that mates with the existing VCO plug.

Countless hours of engineering and implementation went into this retrofit for the FV7F and FV13F radios. The result is a clean and compact pair of replacement components that have superior performance characteristics and require little installation time. The replacement components are a cost-effective alternative to radio replacement or major reconfiguration. Our hope is that those experiencing the same problem will benefit from our efforts.

Acknowledgment: We wish to express our thanks to Robert K. Dye, P.E., director of engineering for the Ohio Educational Broadcasting Network Commission, for his time and cooperation on this project.

Editor's note: Inquiries regarding this modification are welcome and may be made to: David L. Lloyd, maintenance supervisor, ITT Federal Electric Corporation, 2470 North Star Road, Columbus, OH 43221. Telephone: 614-644-3038.

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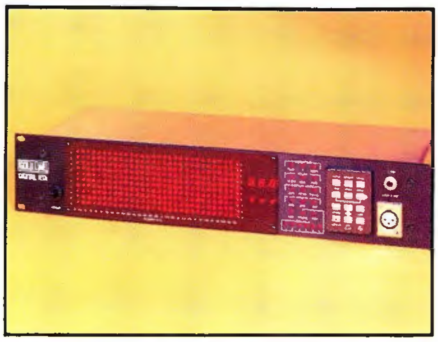
Field report



Goldline model 30 real-time analyzer

By Todd Boettcher

When Hewlett-Packard developed the audio spectrum analyzer in 1970, Altec Lansing was quick to reach an agreement to market the analyzer to its network of sound-reinforcement system contractors. The device accepted a standard audio input signal from either a microphone or line input. A sophisticated filter network divided the signal into 27 1/3-octave bands. The network outputs then drove an oscillographic display to indicate the relative amplitude of each filter output simultaneously. This technique allowed the entire frequency response of the signal under test to be displayed in real time. This *real-time* spectrum analyzer (RTA) provided a significant time savings compared with a swept frequency test.

Modern RTAs

In today's RTAs, a matrix of LEDs has replaced the oscillographic display, with each filter output feeding a column of three or more LEDs to indicate relative amplitude. Even in bright sunlight, the LED display is highly visible, and it is significantly less expensive than an oscillographic display. The trade-off is that an LED display has finite resolution.

Real-time analyzers first gained popularity for measuring acoustical room response curves when equalizing permanently installed sound-reinforcement systems. Because analyzers are relatively easy to use, they have become standard pieces of equipment for setting up temporary sound-reinforcement systems as well. Recording studios also use the analyzer to display spectral energy to aid in setting equalization. Broadcasters now use such analyzers for various test and measurement functions.

Product description

The Goldline model 30 is the company's top-of-the-line RTA. The 19″×10.5″×3.5″ chassis is rack-mountable. Its overall black color improves display visibility. The 30 ISO center bands cover 25Hz to 20kHz. The 10×30 LED display covers the left half of the front panel. The right side of the panel contains a status display and a keypad. The front panel also contains a balanced XLR-type mic input (with 12Vdc phantom power) and a 1/4-inch unbalanced bridging line-level input.

Boettcher is an engineer at WTMJ-TV, Milwaukee.

Performance at a glance

- *30-band real-time equalizer*
- *Six memories*
- *Quartz-controlled switched capacitive filtering*
- *Built-in pink-noise generator*
- *Selectable response curves: flat, A-weighted or user-specified*
- *Peak hold*
- *Printer option*

The back panel has an attached power cord, a fuse post and massive heat sink. The rear panel also provides a 1/4-inch unbalanced output for the built-in pink-noise generator and an expansion slot.

Operation

When the power is turned on, the unit goes through a complete automatic calibration self-test and operational checkout. Control of all functions is microprocessor-based. Commands are entered with the front-panel keypad.

A variety of parameters can be controlled from the keypad. The most visible controllable parameter is the zero-line reference, which is displayed by three 7-segment LEDs. The reference level indicates decibels SPL, and it can be varied 79dB (from 50dB SPL to 129dB SPL). This provides a maximum total display range of 32dB SPL to 138dB SPL. Reference level is adjusted up or down by pressing the corresponding up or down key. If a signal is being fed to the input, two keystrokes will command the RTA to auto-search and set the correct reference level.

Another controllable parameter is display resolution. It is user-adjustable to 1dB, 2dB or 3dB per division. This feature allows maximum display variations of 10dB, 20dB or 30dB.

Also selectable is the response curve: *flat*, *A-weighted* or *user*. The user curve is a factory-installed option, and you must specify it before shipping. It is not user-adjustable. The *decay* (slow, medium, fast) and the *display mode* (average, peak, peak-hold) all are user-selectable parameters.

An important feature on the model 30 is the capability to store displays in up to six independent, volatile memories. Any combination of these memories can be summed to create *averaged* display. This feature is useful because it's often important to repeat measurements at different locations. The results then must be averaged to determine the required equalizer settings. Doing this by hand would be an impossible task.

Options

One optional accessory is the MK-30 calibrated reference microphone. This is an omnidirectional electret condenser microphone with a small-diameter capsule that operates on 12Vdc phantom power.

Also available as options are a balanced output for the pink-noise generator and a balanced line-level input. Although the unit I evaluated had the unbalanced input, the low side of the input appeared to be floating. You will see later why I was unable to confirm this with the schematic.

A useful option that was included in the test unit is a parallel printer interface card. This card, which plugs into the motherboard, has a 3-foot-long flat ribbon cable attached. This cable extends from the interface card through the expansion port opening on the rear panel. The port interfaces directly with a parallel printer, such as an Epson FX-80 or equivalent.

The printer interface also is controlled by the keypad, allowing a finished report to be printed. The printed results include a representation of the LED display and a list of all status parameters. (See Figure 1.) This card also increases the number of stored displays to 30. These displays are stored in non-volatile memory and can be recalled later.

The company is in the process of developing an RS-232 card for direct computer interface. Although it was not available to me for evaluation, it is supposed to be available by the time this report is in print.

Expanded evaluation

The appearance of the model 30 front

panel is professional and easy to understand. After a few minutes of experimenting, most functions could be learned without reading the instruction manual. The instruction manual, intended for nontechnical users, is just a review of keystroke operation. There is one short paragraph on theory of use. The 11-page manual is contained in a 3-ring binder. A 2-page brochure describing the unit contains much of the same information.

It is Goldline's intention that all service work be done at the factory. Therefore, no technical information, schematic diagram or service manual is available to the user.

Construction

Examination of the chassis shows an impressive number of ventilation openings. The massive heat sink dissipates heat from one diode bridge and four voltage regulators. The analyzer, run continuously for several hours, remained absolutely cool, with no sign of heating anywhere. Although protected by a 1A slow-blow fuse, current draw was measured at only 0.25A (about 30W).

After 11 screws were removed, the top came off, permitting a look at the interior. The analyzer contains two power transformers, an LED display board mounted to the front panel, a large motherboard mounted to the bottom plate and five daughterboards held in place only by their edge connectors. The input daughterboard appeared to have several surface-wired modifications. The printer card ribbon cable has no strain relief, so a sharp tug on this cable could damage the card. I'd prefer a rear-panel connector with a detachable cable for the printer interface.

Practical use

The analyzer performed well, with all the various LEDs and functions operating as expected. The matrix display was easy to read and interpret. There are several concerns that need to be mentioned.

The numeric decibel reading for the reference level can be confusing. Although it is calibrated to read decibels SPL, it is accurate only when Goldline's optional MK-30 reference microphone is used. Other microphones will indicate differing SPL levels, based on varying microphone sensitivities. This scale cannot be recalibrated to a user-determined level (such as 0dBm).

Also, when adjusting the reference level up or down, each keystroke will adjust the reference level by the preset amount per division (resolution). The user cannot directly address and go to a specific level. For example, if sensitivity is set at 2dB/division, and the user wishes to go from 100dB SPL (the default level) to 50dB SPL, the down key must be pressed 25 times.

As a point of reference when using this scale for electronic rather than acoustical measurements, 125dB SPL for zero-line reference equals +3.7dBm. Because of finite resolution with an LED display (1dB/division minimum), a measurement error of 1dB (±dB) is possible without a change on the display. This could cause unexpected additive errors in some kinds of tests.

Also, after operating the analyzer for several hours, I noticed that the keypad needed to be pressed firmly for commands. Some keys were producing intermittent contacts, which made control a bit difficult.

Tests

Several tests were run on the unit. First, the pink-noise generator was returned directly to the analyzer input. This test showed that the combined response is +0/−2dB (long-term, using peak-hold). A swept frequency test showed that five of the 30 filters deviated from true ISO centers by more than 1.5% (up to 2.5%).

The MK-30 calibrated reference microphone was compared with a B&K 4004 calibrated microphone having a response of +3/4dB, −0dB from 10Hz to 40kHz. Within the response limits of the analyzer, the MK-30 exhibited a response of +9dB, −3dB across its bandwidth. No calibration documentation was provided for the MK-30.

The printer interface card can provide two qualities of report printing: low resolution and high resolution. The sample shown in Figure 1 is a low-resolution printout. After many tries (using an Integral Data Systems model 480 printer), I could not achieve a successful high-resolution printout. Instead, it printed three pages of gibberish. This may have been a printer problem.

The printer option is handy for permanent documentation of test results. Although more sophisticated, more precise analyzers are available on the professional market, their prices reflect that precision. For the user requiring a general-purpose 1/3-octave analyzer for semi-professional applications, the Goldline model 30 seems to provide good dollar value.

Editors Note: The field report is an exclusive **BE** feature for broadcasters. Each report is prepared by the staff of a broadcast station, production facility or consulting firm.

In essence, these reports are prepared by the industry and for the industry. Manufacturer's support is limited to providing loan equipment and to aiding the author if support is requested in some area.

It is the responsibility of **Broadcast Engineering** to publish the results of any piece tested, whether positive or negative. No report should be considered an endorsement or disapproval by **Broadcast Engineering** Magazine.

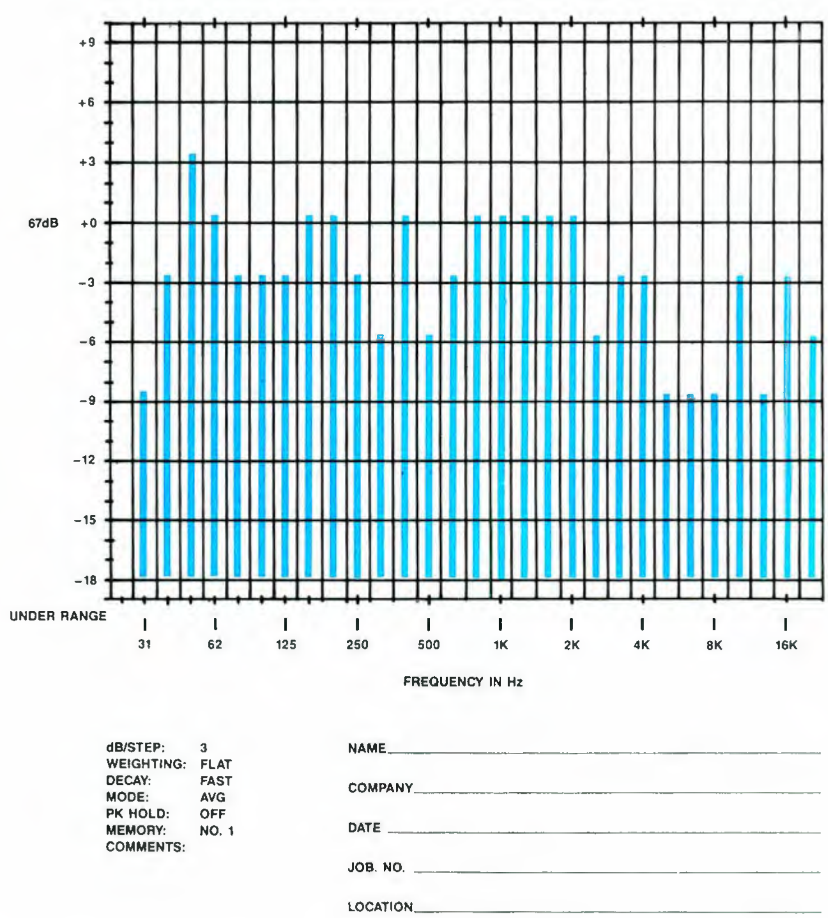


Figure 1. *Printer display of front-panel readout allows you to document any tests made.*

Share your views on society issues

By Bob Van Buhler

At the request of the 1989 SBE president, Jack McKain, executive committee members have begun the process of goal setting and long-range planning. The next decade presents great opportunities and challenges, and the executive committee already has identified some important areas on which to work. Some projects have not progressed as well as the board of directors had anticipated.

Executive director

Foremost among these projects is the widely recognized need for a full-time executive director. Filling this position requires that the board or its appointed committee first determine the cost and identify the needed funds.

An executive director profile never has been developed. Although most board members agree that a full-time executive director is needed, it will be difficult to hire an appropriate person unless the society's expectations are fully documented.

A related issue is whether to move the SBE offices to the Washington, DC, area to achieve what past president Richard Rudman has characterized as "a Washington presence." Because it is unlikely that any members of the national office staff will be willing to move to Washington, the relocation would require assembling an entirely new staff. Also, it would require that the new director understand fully all SBE systems and practices in a relatively short time.

Many board members think that with the help of the society's Washington counsel, Chris Imlay, of Booth, Frerett & Imlay, a staffed Washington office is not necessary. They say an executive director working out of the Indianapolis office could accomplish the same thing with regular trips to Washington.

Although Rudman previously requested members' suggestions on this topic, few comments have been received. Rudman said the board has used the working assumption that moving to Washington is a good idea, but the membership may have other views.

Cooperative agreements

Another issue that affects the membership directly is whether the SBE should involve other organizations (such as NAB) in its convention. This subject has generated many questions that the entire board must address, some of which are listed here:

- the acceptability of such an alliance to the membership.
- whether the society would remain the operator of the convention.
- the necessity or value of bringing in other organizations.
- the role NAB might have in SBE's convention.

McKain has advocated involving the society in joint conventions with the NAB. Most executive committee members expressed concern and suggested that the matter be presented to the full board. This matter could affect the future and autonomy of the SBE convention.

Society priorities

The executive committee members responding to McKain's initiative identified several priorities. According to director, executive committee member and convention co-director Bob Goza, the main priority is education. Goza suggested an emphasis be placed on "the scope and endeavors of the Ennes Foundation. This includes scholarships, rewrite and publication of the Ennes books, certification, curriculum approval of schools and training seminars."

Board members and candidates have identified communication as another important area. The national office and the membership have been linked by "Short Circuits," the "SBE Update" column and the "SBE Signal." Better and more frequent communication is needed, according to most members.

SBE also must work to improve its publicity. This means a wider dissemination of information about the organization's activities. An executive director would be a key contact in this process.

Acting executive director Andy Butler noted that asking the members for their thoughts on the goal-setting process is important. He predicted that the October 1990 board of directors meeting will be a realistic time to debate and adopt a strategic plan for the '90s. However, he emphasized that success depends on the involvement of all members, officers and the board.

Vice president Bob Van Buhler thought that the board of directors too often was presented with "done deals" in cases involving broad policy issues. He encouraged full board discussion on policy issues rather than quick solutions by the executive committee.

Share your views

As a member, you are encouraged to share your views on the priorities and goals of the society for the 1990s. Send your comments to the SBE, 7002 Graham Road, Suite 216, Indianapolis, IN 46220. All comments will be distributed to board members for consideration and action. Members are advised to provide positive and constructive suggestions about specific problems.

Van Buhler is manager of engineering at KNIX-AM/FM, Phoenix.

Editor's note: For additional information about SBE activities, !GO BPFORUM on CompuServe.

Broadcasting in a borderless Europe

By John Blau,
BE's European correspondent

The single European market is now more than just a grand vision. It's becoming an economic reality and, by 1992, it will have a profound and permanent impact on many industries. Broadcasting, for one, will never be the same.

Driven by new technology, deregulation and now the move toward a united Europe, broadcasting entrepreneurs are vastly expanding commercial television, both in satellite and conventional channels. And they're moving fast, because a borderless Europe will represent a market of about 320 million people — almost 70 million more than in the United States.

One of the most striking changes involves direct broadcast satellites (DBS), which cross effortlessly over national borders and bypass conventional networks and local stations. In October 1988, France launched TDF1, Europe's first working DBS, followed earlier this year by Luxembourg's medium-powered Astra, as well as West Germany's medium-powered Kopernikus and high-powered TV-Sat 2.

Satellite technology, however, is only a part of Europe's TV revolution. In fact, it might be eclipsed some day by the rapid expansion of cable networks and developments in Integrated Services Digital Networks (ISDN) and Integrated Broadband Communication Networks (IBCN). "It's a lot like the U.S. in the late '70s and early '80s during the cable boom," said Mark Booth, chief executive of Maxwell Entertainment Group. No one knows exactly where the revolution is headed.

Not even the Brussels-based Commission of the European Community (EC), which started the ball rolling, knows. When the 12-nation EC enacted the Single European Act two years ago, it set 1992 as the deadline for creating a true Common Market, in which goods and services will flow freely across national borders.

To a large extent, the Commission was responding to the need to spur growth within the EC and to support European industry. Call it "Fortress Europe," call it the United States of Europe, call it whatever you like. The fact is that the billions of dollars at stake in such global technologies as DBS, ISDN and HDTV have persuaded the Commission officials of the need to join forces and act fast.

New technology, particularly DBS, has been the catalyst for change in European broadcasting. The governments of Europe recognize that their decades-old restrictions on broadcasting are no longer effective now that programs can be beamed across borders by satellite.

Over the next three years, Europe plans to launch up to 11 TV satellites at a cost just short of $3 billion. With the likely outlays for production facilities, marketing, programming and other items, the cost could far exceed that. The drive behind this spending is the vision of a vast, pan-European market — one that advertisers would spend billions of dollars to reach via the Continent-spanning "footprint" of satellite signals. European TV advertising amounted to only $9.6 billion last year, compared with $25 billion in the United States. Nevertheless, European spending on TV advertising in 1989 is projected to increase by 18%, and this strong growth is expected to last well into the 1990s.

Betting millions that the pan-European scenario will unfold, especially after 1992, are some of the world's largest media moguls — Rupert Murdoch, Ted Turner, Robert Maxwell and Silvio Berlusconi — as well as European governments, banks and entrepreneurs. British Satellite Broadcasting (BSB) predicts, for example, that within the next 25 years, it will have more than 10 million viewers, generating $1.7 billion in revenues from advertising and pay-TV fees.

But there are also some fortunes to be lost. Murdoch's London-based Sky Channel, which was the big groundbreaker for pan-European TV, has lost more than $100 million since it started to beam programs throughout the Continent. Murdoch has since renamed his channel Sky Television and has focused on the U.K. market.

Losses such as these clearly show that satellite television in Europe isn't without its problems. Industry experts place much of the blame on Europe's highly fragmented market, with a dozen languages spread over 21 countries. Added to this are the sluggish sales of dish antennas (only about 50,000 Europeans are said to own one) and the race with cable television. In some of the smaller markets, such as Belgium (87% cabled), satellite appears to have lost already. The typically cabled home in Brussels already receives four French channels, three domestic, three German, three Dutch, two from the BBC, one each from Luxembourg and Italy, plus Sky and Super. Viewers really don't have much reason to look skyward.

The idea of completely transforming Europe's TV map, however, goes beyond satellite and cable technology. It implies a fresh approach to a number of old obstacles. Among those most important to the broadcasting industry are the establishment of ownership rules, the coordination of national laws on advertising, the free flow of programs among EC members (although national broadcasts could remain subject to separate rules) and the removal of technical barriers. Coinciding with this ambitious program, and making it that much more difficult to implement, are the

Members of the European Community:

France, West Germany, Italy, Luxembourg, Belgium, Netherlands, Denmark, Great Britain, Ireland, Greece, Spain and Portugal.

Members of the European Parliament:

Austria, Belgium, Cyprus, Denmark, France, West Germany, Greece, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, Malta, Netherlands, Norway, Portugal, San Marino, Spain, Sweden, Switzerland, Turkey and Great Britain.

Table 1. *The European Parliament, which has been around much longer than the European Economic Community, has been overshadowed by the EC in many areas, especially in economic matters. But the Parliament has been a strong force in the broadcasting arena, and it now looks as if the EC will adopt many of its rival's initiatives.*

massive evolutionary changes in television itself, notably the development of HDTV.

How these issues will be resolved depends largely on the outcome of the separate proposals put forward by the 12-member EC and the 21-member Council of Europe. Both are pushing for greater unity in cross-border television, surpassing the commercialization and deregulation of European broadcasting in recent years. They differ primarily in their approach, ownership being a case in point.

Few laws on ownership

As European national broadcasting companies begin to compete effectively Europewide, the bigger ones will get bigger, the smaller ones may go belly up, and medium-sized operations will struggle to survive through mergers and acquisitions.

"We've been following this trend for the past few months," admitted one industry expert, referring to Europe's media lords such as Maxwell and Berlusconi, who have been busy acquiring, creating or merging media companies across European frontiers. The lines of ownership quickly are becoming blurred.

Indeed, underlying much of the debate over post-1992 European television is one simple question: Who will own the broadcasting outlets? There is no single European law on ownership. Under most national legislation, ownership of TV stations by other European Community members is not an issue. Laws generally permit investments in TV channels, provided reciprocal arrangements exist.

There are some notable exceptions:

- Flemish-speaking Belgium, Portugal and Spain have put a ceiling (in some cases, up to 25%) on foreign ownership.
- France limits foreign owners to 20% of terrestrial broadcasters.
- German laws restrict concentration of media holdings. Anyone controlling more than 20% of a German region's or city's newspaper circulation is not allowed to own more than 50% of a TV station.

The Council of Europe is expected to hand down some guidelines shortly. But these limitations, ironically, may actually make it easier for non-EC companies to move in, because they are unlikely to be saddled with the conflict of controlling local newspapers.

The United States, considered the likeliest source of new investors, has a ceiling of 25% on foreign ownership in its own communications companies. But there is no European law stipulating that American holdings in European companies must remain within that limit. Currently, each member state can determine the level of ownership by non-EC companies. The European Community, quipped one official, hasn't been "very successful in harmonizing the rules on television ownership by non-Community nationals."

But the commissioners are trying. They have attempted to deal with these problems in their "Directive on Television Without Frontiers." This and the Green Paper on which it is based have been the subject of much discussion. The council's "Convention on Transfrontier Broadcasting" takes a more pragmatic and flexible approach to the problems of cross-border broadcasting by establishing a set of minimum standards.

Advertising to finance deregulation

Advertising, for example, is one area where the European Council doesn't want to impede progress. Money is needed to finance Europe's hefty deregulation. Some of it will come from the export of new European programs, but most of it will be raised through advertising. Understandably, public service broadcasters, financed by license fees from the public, aren't excited about this development. They're being forced to compete with a rapidly expanding group of commercial channels that have money to spend on popular shows and are successfully expanding their viewer audiences. The dominance of government broadcasters is expected to erode at a quickening pace throughout the '90s.

As to the amount Europe spends on advertising, forecasts vary, but the general consensus is that it will be up 2.5 times the increase in the United States over the next few years. According to Saatchi and Saatchi, major U.S. media have grown by 9.5% in real terms in the past three years, Italy's have grown by 22.7%, France's by 27.5% and Spain's by a staggering 27.4%.

Although commercial television has been frowned upon by many Europeans (Sweden, for example, still allows no commercials), the situation is changing. Even the diehards now realize that, like it or not, commercial television is in Europe to stay.

Quota on U.S. programs

One of the most hotly disputed issues in the debate over cross-frontier broadcasting in Europe is programming. Just weeks after the proposed merger between Time and Warner Communications, the EC and the Council of Europe approved a directive stating that, starting in 1990, European TV stations should devote the majority of their airtime to European-made programming. By slapping a quota on production, both of these agencies clearly have shown that they want to limit American TV imports and spur domestic productions.

This means European producers will need to come up with hundreds of thousands of hours of programming per year. And, as airtime increases with the proliferation of cable satellite channels, the demand for new films and shows could more than double by 1995.

The directive is so vague, however, that it could be months before producers know how strictly it will be enforced. There's little doubt that it will put European TV stations under pressure to co-finance European programs. The quotas (they could be as high as 60%) are certain to put new life

Distribution:
- European Film Distribution Office
- European Cinema Club
- Espace Video Européen (EVE)
- European Fund for Multilingual Audiovisual Production (Babel)
- European Organisation for an Audiovisual Independent Market

Production:
- Investment Club for Advanced Technologies
- Production in HDTV/MAC standard
- Synthetic TV
- Support Structure for Script Development
- Association Européen du Film d'Animation (AEFA)

Training:
- European Audiovisual Entrepreneures Scriptwriting
- European Certificate for Cinema and Television Literature

Financing:
- Venture Capital
- Guarantee Fund

Table 2. *The EC's initiatives on cross-border broadcasting are coordinated by MEDIA 92 (Mesure pour Encourager le Dèveloppement de Industrie Audiovisuelle). The organization, with a somewhat mediocre budget of about $7 million, is committed to contributing no more than 50% of the total cost for any single project with the remaining money expected from outside sources. The programs listed here fall under the MEDIA 92 umbrella.*

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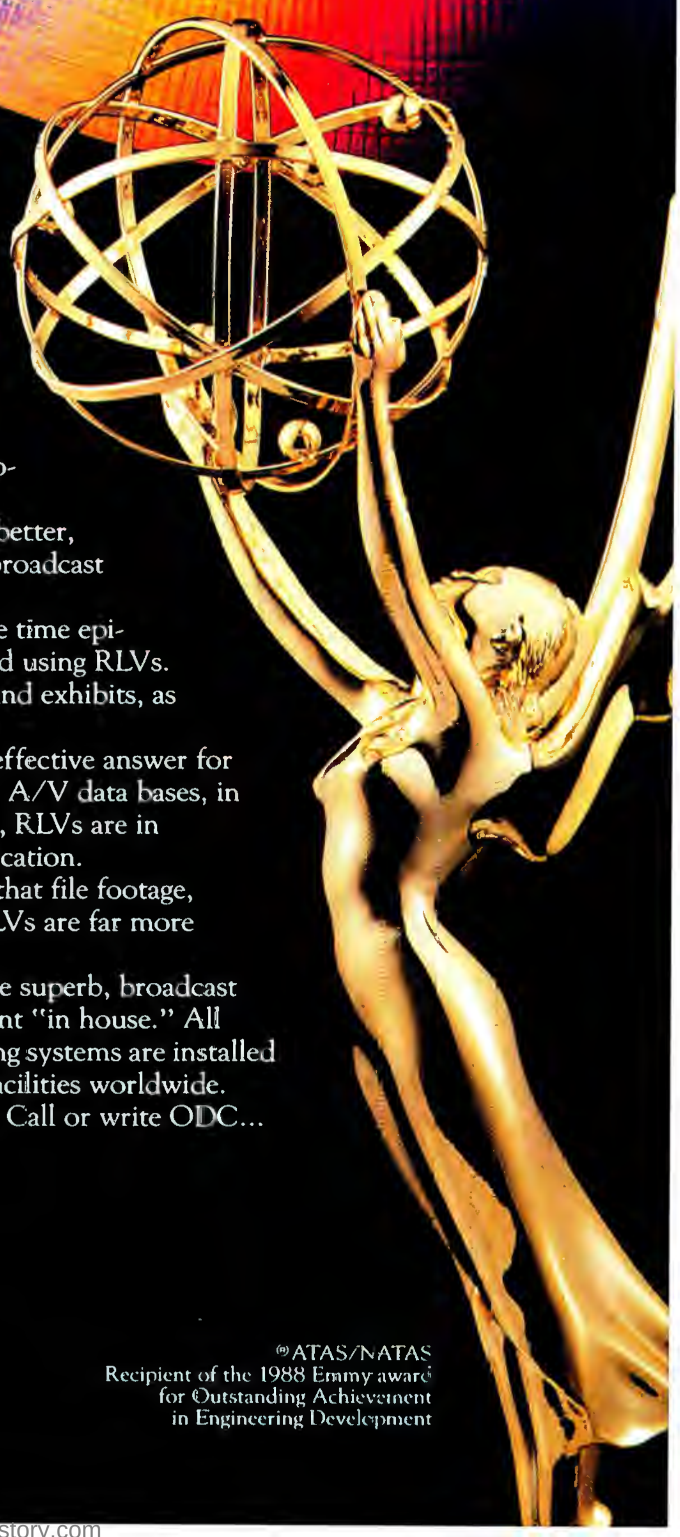

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in Engineering Development

into Europe's media. If the ruling holds, the two major roadblocks to Europe's TV show producers — fragmented markets and lack of financing — could be overcome, and a profitable European-run TV industry could blossom.

Europe's big players already are talking deals. Italian commercial TV magnate Berlusconi has announced talks with British publisher Maxwell to create a $1 billion entertainment group, which would produce and distribute TV serials and films throughout Europe.

France's leading commercial station, TFL1, which is 25% owned by French construction tycoon Francis Bouygues, also has announced an agreement with Berlusconi and West Germany's Leo Kirch to co-finance European programs. In addition, the French pay-TV Channel plus is setting up a new company with Germany's Bertelsmann (the world's largest media concern prior to the Time-Warner merger) to provide a pay-TV service in Germany. The new company also is bidding for channels aboard the French TDF1 direct broadcast satellite.

To encourage private efforts to develop a European TV industry, French president Francois Mitterand (the major figure behind Europe's efforts to curb U.S. TV exports) also has obtained approval of other European governments to launch a new EC entertainment-subsidy program, similar to the Eureka research program.

Standards crucial to unity

This show of support for European programming also has spread to the technical front, where the EC is under considerable pressure. There is a profound need to establish standards in Europe. Without them, especially in such a critical sector as broadcasting, information can't flow across borders. And that's devastating for the broadcasting business. Philips NV, the Dutch electronics giant, estimates that it spends an extra $17 million per year to design and manufacture seven different versions of the same TV set to meet different standards worldwide.

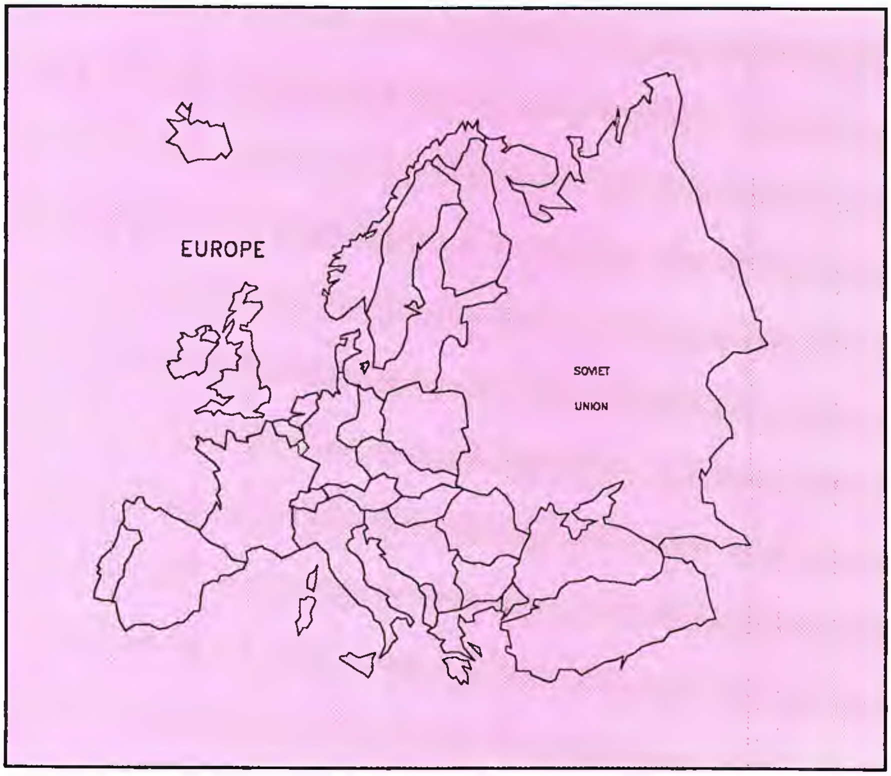
If Europe is ever to have a common market for television, it will have to agree on technical standards. It hasn't been successful at this in the past. European governments and electronic industries have a long history of developing their own standards, such as PAL and SECAM; the family of MAC (multiplexed analog components) systems, including C-MAC, D-MAC and D2-MAC; or the many different encryption methods to access the various forms of pay-TV.

The need to cooperate is underscored in the battle raging over a global HDTV standard. This new emphasis on cooperation is based on the growing realization that Europe wants to halt Japan's world domination of high technology.

France's Thomson, the Netherlands' Philips and Germany's Bosch, along with a dozen or so smaller companies, have been working together in "Project 95" under the Eureka umbrella of high-tech research programs. The consortium was formed in 1986 to develop an HDTV system specifically for the EC. Although it was less than two years old at the time, the group demonstrated a live satellite-delivered HDTV broadcast in September 1988 at the International Broadcasting Convention in Brighton, England.

But the battle is hardly over. A crucial meeting comes up this month when experts from around the world meet in Geneva to debate global HDTV standards due for adoption by the end of 1990.

The stakes are high. The European market for HDTV hardware and software is estimated at $222 billion, and that's a conservative estimate. What's more, experts expect HDTV to become the cornerstone for a wide array of electronic products —



from home-entertainment systems to medical imaging and even to defense radar equipment.

The EC isn't taking any chances. In April, for example, the Commission cleared Britain and Germany to make state grants totaling $75.3 million for research on HDTV. The EC said that because Japan already has developed its HDTV technology, and the United States is working on its own, it is "important to encourage European research in this area to enable a European alternative." For that reason, the Commission exempted Britain and Germany from rules on state aid that seek to prevent trade-distorting subsidies.

Sounds a lot like Fortress Europe. How integrated the single market will be in relation to the outside world is still the big question. But one thing is for certain: Europe doesn't want to be divided up and conquered any more by the Japanese and Americans. In terms of broadcasting, this could spell trouble for U.S. TV programmers who see a vast market opening up but who are likely to face stiff production quotas. And it could mean the same for the broadcast industry, which, even if the world decided on an HDTV standard, could find Europe as fortified as ever.

Continued from page 46

Calling all engineers

To hear some tell it, broadcast engineers are as hard to find as hen's teeth. Based on survey comments, it's usually the older engineers who tell it. They seem more concerned than their younger counterparts about where the next generation of broadcast engineers will come from.

Is there a shortage?

The issue is raised every year in both the **BE** salary survey and the state-of-the-industry survey. Broadcast engineers claim there is a shortage. Yet, a survey of trade publication job listings does not indicate a large increase in demand. In addition, the best indication of a shortage of engineers would be increasing salaries. This year's survey shows no sign of pressure to draw new people by inflating salaries.

Still, concern exists about finding young people with an interest in broadcast engineering.

Other areas pay more

A check with electronics schools reveals why young people may not be entering broadcasting. A national school that offers two levels of electronic training programs — an associate's degree in electronic technology and an engineering technology degree — provided additional information.

A student graduating with an associate's degree in electronics earns approximately $17,900. The engineering technology degree increases that figure to about $25,000. In each case, location, company size and student qualifications affect the actual figure.

The school reported that few of these graduates enter broadcasting. The reason is twofold. First, large-market stations, those that could pay a competitive salary, will not hire inexperienced technicians. Second, to get that experience, the student must look to smaller stations with correspondingly smaller salaries.

This creates a serious dilemma for broadcast engineers-to-be. Unless they are willing to move to a small market and accept lower pay for several years, an adequate salary in broadcasting may not be possible. Granted, typical graduates may be young, perhaps without families to support, but they still have to eat. Few graduates seem willing to make that sacrifice.

Research shows that radio stations are not looking for graduates. Nor are electronics school graduates particularly interested in radio. The reasons can be summed up in four words: low pay, long hours.

News
Continued from page 4

niques. His areas of involvement will include data collection and management systems, automation systems in the ATTC laboratory and specialized computer and digital equipment. Hamilton was most recently senior consultant with GE Information Services.

ATSC relocates office

The Advanced Television Systems Committee has moved to 1776 K Street NW, Suite 300, Washington, DC 20006. The committee also has changed its telephone numbers. The new numbers are: (telephone) 202-828-3130 and (fax) 202-828-3131.

Comark installs fifth Klystrode-equipped transmitter

Comark Communications, Colmar, PA, has announced that it has placed a 60kW Klystrode-equipped transmitter into full-time broadcast service at WTCI-TV, Chattanooga, TN. Comark, a Thomson-CSF company, installed its first Klystrode-equipped system at Wrens, GA, in June 1988.

Over the next several months, the company plans to install Klystrode-equipped systems at WLCP-TV, Chatsworth, GA; KSLD-TV, Riverside, CA; and WBFF-TV, Baltimore. Comark projects that at least 20 Klystrode tubes will be in full-time broadcast service by the end of the year.

Brighton still home to IBC

Members of the IBC Management Committee have agreed that the International Broadcasting Convention should continue to be held in Brighton through 1992. The decision was made after consideration of facilities offered by the SECC in Glasgow. The consensus of the committee is that Brighton offers the best available exhibition space, accommodations within traveling distance and facilities for the technical sessions.

News from Europe

By John Blau, European correspondent

Germans tune in to TV

West Germany now has more viewers of cable and satellite television than any other country in Europe, according to a recently published report by the London-based PETAR research group. An estimated 11.75 million West Germans regularly view cable channels, an increase of nearly 50% compared with last year. Almost half of all West German households receive cable television.

Some question future of TV-Sat 2

West German broadcasters are voicing doubts about the future of the country's first high-power direct broadcast satellite, TV-Sat 2, which was successfully launched in August aboard the Ariane 4 rocket. TV-Sat 2 is the twin sister of the $450 million

Continued on page 180

Taking matters in hand

The solution to finding competent engineers is complex. Although there is no single best answer to the problem, positive steps can be taken. Those interested in climbing the ladder of opportunity will need to make some changes in the status quo.

Stations needing quality talent will begin to look for engineers just as they seek out program directors, on-air talent and other professionals. They will scrutinize the experience, qualifications, industry certification and track record of the candidate. If you're an engineer who's already in the business, you should expand your own abilities and skills. Visibility with management will become even more important. You must begin to sell yourself to the manager. Unless that person recognizes the value of your efforts, your situation is not likely to improve.

Management skills will become crucial. If you can't relate to the needs of a program director, you are not as effective as you could be. Being able to deal with people, not just equipment, is important. Engineers must be able to manage time and resources effectively, develop budgets and work as team members. Gone are the days of the electronic guru. You have to be much more.

These steps will help current broadcast engineers advance their careers. Stations needing new talent must take matters into their own hands.

Stations should develop internship programs. The best way to guarantee a ready supply of new talent is to participate in its growth. Pay the interns a reasonable salary, and expect them to perform well. Use this time to teach the new people about the business. You will find them eager to learn.

The advantage to the station is a ready-made source of trained talent. The advantage to the industry is that the new people might just stick around.

Does certification pay? You can bank on it.

Each year we review the results of the survey to determine whether SBE certification makes any difference in salary. If you've read any of the reports from the past four years, you already know the answer.

SBE-certified engineers tend to earn higher salaries than those who are not certified. In the beginning, some thought that the results were inconclusive. It was sometimes referred to as a "chicken-and-egg" situation. Did higher-paid engineers become SBE certified, or did SBE certification help engineers progress up the ladder to higher salaries? It's time to put that question to rest.

Numbers tell the story

The results are summarized in the accompanying table. It shows that measured over all markets, for radio and television, the SBE-certified engineer earns $35,300. This is $3,900 higher than the non-certified salary.

And there are other reasons to become certified. The median salary of the SBE-certified TV engineer is $40,250. The non-certified counterpart earns only $33,700 — a difference of $6,550. Radio salaries show similar results. The SBE-certified radio engineer's median salary is $30,000. The non-certified counterpart's salary is $28,700.

The accompanying graph illustrates clearly the differences in salaries. Whether you compare the results across all engineering categories or compare television and radio categories separately, SBE-certified engineers earn more.

If you'd like more information about SBE certification, contact the SBE national office at 317-842-0836. Or write to the certification secretary, Society of Broadcast Engineers, 7002 Graham Road, Suite 216, Indianapolis, IN 46220.

	Total	Total TV	Top 50	Top 100	Below Top 100	Non-C	Total Radio	Top 50	Top 100	Below Top 100	Non-C
Median salary	$31,900	$34,500	$45,800	$31,300	$24,250	$32,100	$29,000	$39,650	$29,000	$21,750	$27,000
Certified salary	$35,300	$40,250	$48,950	....	....	$38,750	$30,000	$40,700	....	$20,000	$24,400
Non-certified salary	$31,400	$33,700	$44,750	$32,000	$24,150	$30,900	$28,700	$38,900	$28,800	$22,200	$27,500

SBE-certified engineers tend to receive higher salaries than their non-certified counterparts. The trend has continued for the past four years.

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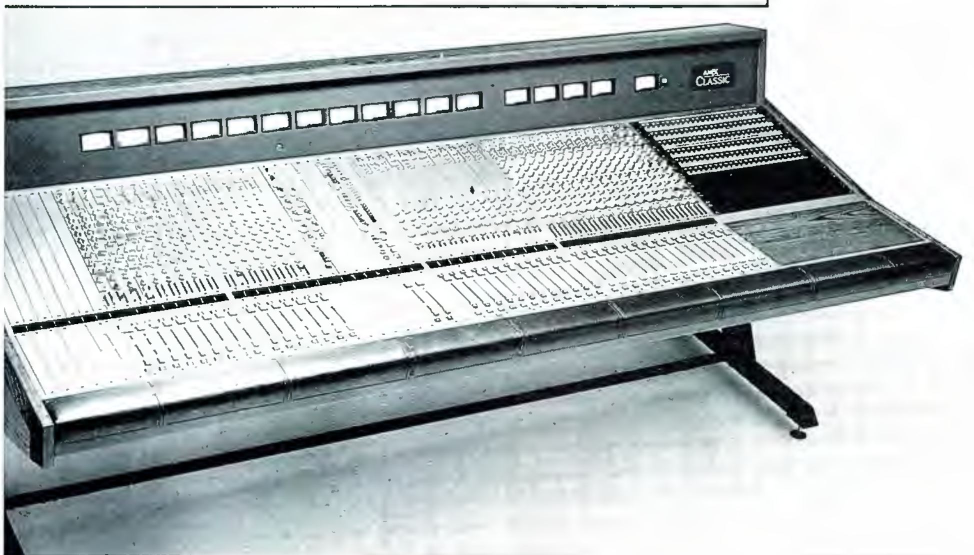

AMEK's large range of advanced audio consoles offers an unequalled choice to Broadcast and Video Post facilities.

For situations where compactness and simplicity of operation count, AMEK BCII has many desirable features. The BCII equipped with our ESM32 AFV (Audio Follow Video) interface provides a simple package solution to problems of integrating a complete audio control system into a Video Edit environment. BCII/ESM32 provides quality audio - not 'video' audio - with monitoring and preview of audio sources. Audio can follow or be independant, and various cross-fade patterns are allowed for. The protocols support a vast range of equipment from major editor suppliers such as AMPEX, CMX, GRASS VALLEY and PALTEX. Standard AMEK-specified packages of desk and interface are readily available, but custom flexibility is catered for.

Beyond the package stage, AMEK BCII offers a wide range of options. CONFIGURATIONS as diverse as a simple 6-in, 1-out through to 24-in, 4-subgroup, 2-out can be provided with ease.

MODULES include Mono and Stereo inputs, Mono and Stereo subgroups and outputs - with or without Dynamics - and several monitor sections for all control room, studio and production gallery requirements.

CHASSIS not only include 16, 24 and 32-position frames in table top, drop through and portable formats but also a complete free-standing studio desk which can include jackfields and extra racking space.

METERING is moving coil-type and options include VU,BBC and DIN-spec PPM.

AMEK CLASSIC is built on a much larger scale and is eminently suited for use not only in Broadcast and Video production but also in Film Post, with or without multitrack Buss/Tape monitoring facilities.

Many configurations are possible. Standard features include 4-band fully-swept equalization, 8 auxiliary send busses, 8 mono or 8 stereo subgroups, and two seperate stereo busses.

Stereo input modules are fully M/S capable and Image Width control as well as Pan is provided. DYNAMICS modules which include compressor-limiters and expander-gates can be fitted.

CLASSIC is also available with the GML Moving Fader automation system for up to 96 faders, or with various VCA-based systems if less sophistication is required.

Beyond this, various multitrack and video-post production console exist in the general range, including AMEK G2520 and the fully-digitally-controlled APC1000 which features Recall, Reset and Assignable system.

AMEK consoles are used in many of the world's major production facilities, such as the BBC, ITN, MOLINARE, NBC and THAMES TV. We have a complete capability and without doubt are counted as one of the world's leaders in audio mixing technology.

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Business

Ardent and Stellar to merge

Ardent Computer and *Stellar Computer* plan to merge. Stardent will be the name of the newly created computer and visualization company. It will maintain facilities at current Ardent and Stellar headquarters. The companies plan to combine their product lines with full compatibility achieved by early 1991.

Stardent Computer will develop, manufacture and market graphics supercomputers, departmental supercomputers and interactive 3-D visualization software.

Brabury España is established in Europe

Brabury Porta-Pattern has established Brabury España SA in Madrid, Spain. This is in accordance with the company's 1992 single-market strategy to provide a more cost-effective means of trading with its European partners. Other preparations are being made to establish similar trading offices in major cities throughout Europe, including Brabury Hellas in Athens, Greece.

Comark gets contract for UHF TV station

Comark Communications, Colmar, PA, has signed a contract to supply UHF TV transmitters to the Ministry of Information of Kuwait. The Abduly TV Project, located in the Northwest part of the country, has been in the planning stages for the past three years. It will be the highest power (480kW) TV station outside of the United States, with the tallest tower (2,000 feet) in the Gulf region.

This station is the second of its kind in Kuwait. It will provide two channels of programming. Each channel will have a transmitter output power of 240kW. Each 120kW transmitter is capable of operating on its own directly into the antenna system.

Hit Design forms

Family Marketing Group, Ocala, FL, has formed Hit Design, which will manufacture broadcast and related products. The company is diversified, providing standard and customized products to engineering services and support.

Bonneville and Wold form Keystone Communications

Wold Communications, Salt Lake City, and *Bonneville Satellite Communications* have completed an agreement that combines the assets and operations of both companies into a new entity, Keystone Communications. Keystone will own and operate satellite uplink and downlink ground facilities, videotape playback, post-production and master-control centers and mobile and fixed microwave links in New York, Washington DC, Salt Lake City, Los Angeles and San Diego. In addition, the company will own and manage transponder capacity in both C- and Ku-band.

Keystone Communications will continue operations in the cities where the two companies currently maintain offices. Salt Lake City will serve as the company headquarters.

Klark-Teknik heads East

Klark-Teknik, United Kingdom, has established a subsidiary company in Singapore, which will market and distribute its products in Southeast Asia.

Solid State Logic opens two offices

Solid State Logic, Oxford, England, has opened an office in Canada. It is based in Toronto, and will provide sales service support for SSL's client base. The office is located at 36 Toronto Street, Suite 850, Toronto, Ontario M5C 2C5 Canada. The telephone number is 416-363-0101; the fax number is 416-360-3838.

SSL also has opened an office in London. The address is 5 Southwick Mews, Sussex Village, Paddington, London W2. A fully equipped service center will provide spares and service backup. A demonstration facility will provide users training close to London's studios. The office will be used to host client-support functions and introductory demonstrations of the company's product range.

Studer acquires IMS

Studer International A.G., Regensdorf, Switzerland, has completed the acquisition of Integrated Media systems (IMS), Menlo Park, CA, through a U.S. holding company based in Nashville.

The move has brought the IMS hard disk workstation, Dyaxis, into the Studer product line. It will be available through Studer's existing worldwide sales network, while future product development at the IMS Silicon Valley facilities will be carried out and expanded in close cooperation with the Studer ogranization in Switzerland.

The IMS organization has changed its name to Studer Editech Corporation (SEC) and operates as a wholly owned subsidiary under the Studer International umbrella.

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Robert Karadezian of The Pacific Group has been appointed to represent Ergo Industries, Anaheim, CA. He will represent the company's line of products in Southern California, Arizona, New Mexico, West Texas, Southern Nevada and Hawaii.

Daniel Beaton has been appointed vice president of manufacturing and administration for Ross Video, Iroquis, Ontario, Canada.

Susan Hays Roberts and **Raymond Jones** have been appointed to positions with BERC, Broadcast Equipment Rental Company, Burbank, CA. Roberts has been promoted to sales manager. She also will continue in her responsibilities as video production consultant. Jones is director of corporate/industrial sales. He is responsible for maintaining and supporting existing industrial and corporate accounts, along with promoting and servicing new clientele.

Lyn Kessler and **George F. Sabbi** have been appointed to the sales staff of Bash Theatrical Lighting, North Bergen, NJ.

Howard Ellman and **Jim Pianowski** have been promoted to positions with ROSCOR, Mount Prospect, IL. Ellman is national sales and marketing manager. He will oversee the sales and marketing effort on a national basis. Pianowski is manager of systems and technical sales. He is responsible for the promotion of the System Division on a national basis. He also will target certain key emerging technologies for further development and promotion.

Eelco Wolf has been appointed vice president, corporate communications, with Agfa, Ridgefield Park, NJ. He is responsible for all corporate communications efforts, including employee and customer communications, community relations, public relations and corporate advertising. He also will coordinate the internal and external communications activities of the company's three operating divisions — Agfa Photo, Agfa Compugraphic and Agfa Matrix.

Doug Buterbaugh, Jorge Castaneda, Greg Gambill, Shawn Underwood, Roger Harvey and **Tom Deyo** have been appointed to positions with BTS, Salt Lake City. Buterbaugh is Western zone manager. He is responsible for nine states and oversees the direction of five salespeople. Castaneda is a regional sales manager. He is responsible for Latin America, the Caribbean and Puerto Rico. Gambill is Southwestern regional sales manager. He is responsible for Arkansas, Oklahoma and north Texas. Underwood is a regional sales manager for the Midwest. Harvey is a regional sales manager responsible for the Southeast region. Deyo is a regional sales manager and is responsible for selling professional products in the Midwest.

Mitchell Montgomery has been appointed regional sales manager for Comark Communications, Colmar, PA.

Jim Kurowski has joined Studer Revox America, Nashville, TN, as director of technical operations. He is responsible for all technical operations at SRA (Studer, Revox and Revox hi-fi) uniting service and support for the entire product line.

John Sacchetti has joined the Digital Processing Recorder DPR100 development team of Symetrix, Seattle. His first assignment on the DPR project includes design of interface circuits for SMPTE, VITC and house sync.

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Colin Pringle and **Michel Yves Gueguen** have been appointed to positions with Solid State Logic, Oxford, England. Pringle is marketing director of the group and its subsidiaries. He is based at the company's Oxford headquarters. Gueguen is managing director of the French subsidiary, Solid State Logic Sarl. He is responsible for the management of the French subsidiary and is based at the Montigny le Bretonneux office.

Michael T. MacKay and **Robert Ott** have been named to positions with Sony. MacKay is manager of graphics products for the Sony Advanced Video Technology Center (AVTC) in San Jose, CA. He is responsible for managing R & D projects for the development of graphics-related products in the areas of special effects, editing and human-interface technology for HDTV production equipment and for current broadcast video systems. Ott is national business manager of microphone products for the Sony Professional Audio Division, Teaneck, NJ.

John Margardo has been promoted to Northeastern regional manager for For-A Corporation of America, Newton, MA. He is responsible for sales and support of professional video and audio broadcast, post-production and industrial/CCTV products from Maine to Virginia.

Ed Ries has been appointed general manager of the newly formed optical and video test division for Nalpak Video Sales, El Cajon, CA. He is responsible for new product development, quality control and domestic and international marketing.

Nyal D. McMullin and **Walter E. Werdmuller** have been named to positions with Pinnacle Systems, Santa Clara, CA. McMullin has been elected to the board of directors and is chairman of the board. Werdmuller has been promoted to director of worldwide sales, a new position with responsibility for both U.S. and international sales and marketing activities.

Bill Cudina has been named Eastern regional sales manager of Rank Cintel, Valley Cottage, NY. He is responsible for sales of all post-production and broadcast products in New York and New England.

Robert Gilbert, John F. Phelan, Donald S. Schroeder, Michael Pettersen and **Alan B. Shirley** have been appointed to positions with Shure Brothers, Evanston, IL. Gilbert is vice president, sales and finance. He is responsible for the management of financial operations and sales activity worldwide. Phelan, director of technical markets, will oversee marketing efforts for professional products, sound reinforcement products and communications products. Schroeder assumes responsibility for the overall management of all the company's microphone product lines worldwide. He has been promoted from marketing manager, sound reinforcement products. Pettersen is director, mixer products and is responsible for management of all automatic and manual audio mixer product lines, as well as serving as a liaison to electro-acoustical consultants around the world. Shirley is product line manager, wired microphones. He will direct the daily management of all the company's wired microphone product lines.

James Hudmon, Ginny Faison and **Bruce Robertson** have been appointed to positions with Quanta, Salt Lake City. Hudmon is national sales manager. He is responsible for the Midwest and Northeast territories. **Stephen DiFranco** has been promoted to product specialist for Quanta Editing Products. Faison is marketing director. Robertson has been added to the marketing group and is responsible for mid-range character generators.

Danny Mundhenk has been promoted to Eastern regional sales manager of Solid State Logic, Oxford England. He is responsible for managing all SSL sales activities in music and film recording, postproduction and broadcast throughout the Eastern United States.

Manfred N. Klemme has been appointed marketing manager for Cinema Products, Los Angeles. He is responsible for new product introductions.

John Wesley Nash has joined Communications Engineering, Alexandria, VA, as vice president of engineering. He is responsible for corporate planning, project management, new technology investigation and implementation, system design and execution, scheduling, vendor interface and manpower management.

Murray A. Merson has been appointed vice president, sales and marketing for Cool-Lux Lighting, Hollywood, CA.

Peter D. Glassberg has been named Northeast regional manager for Digital F/X, Mountain View, CA. He is responsible for the direct sales and marketing of the DF/X 200 integrated digital production system and the Composium digital edit suite.

Rick Bossert has rejoined EEV, Elmsford, NY. He is responsible for the sale of the Leddicon and Vidicon camera tubes in the Northeastern and North Central states.

Charles Lange and **Alan Feckanin** have been appointed to positions with Altec Lansing, Oklahoma City. Lange is vice president of sales and marketing. Feckanin is district sales manager for the Southeast portion of the United States. He provides liaison to the factory for the company's sound contractors and represents the company to acoustical consultants, architects and engineers.

Gary Taylor has been appointed to a position with AMEK Broadcast Sales Department, Hollywood, CA. He is broadcast sales coordinator and is responsible for factory sales support to the company's worldwide dealer network.

Chas Rowden has joined AMS, Seattle. He manages the London sales office based at Primrose Hill, NW1.

The board of directors of Ampex Recording Media, Redwood City, CA, have elected new company officers. They are as follows: **Richard A. Antonio**, vice president, sales and customer service, United States; **George F. Armes**, general manager, instrumentation products; **Clara R. Munley**, corporate controller; **Eugene R. Nyland**, vice president, operations; and **Phillip M. Ritti**, general manager, audio-video products.

Alan Bunting has been appointed sales director at AVS, England.

James F. Faith has been named Western regional product support manager for broadcast and graphics products for BARCO Industries, Los Gatos, CA. He is responsible for service and technical support for the entire line of the company's broadcast and graphics products in the Western United States.

David Bartolone has been named systems engineer for B & B Systems, Valencia, CA. He serves as project manager in the systems division.

Harry Nelson has been appointed operations manager of the Engineering Center for Belden Wire and Cable, Richmond, IN. He is responsible for planning and directing the process development, quality procedures, manufacturing, material control, accounting, plant engineering and maintenance functions. He also is responsible for development and documentation of the process technology for both custom and standard new products.

Ira Friedman has been named director of the newly formed corporate marketing department for Boston Acoustics, Lynnfield, MA. He is responsible for business development, dealer support, consumer advertising and press relations.

Julie Buck and **Greg Hoskin** have new positions with CEL Electronics, Essex, England. Buck is marketing manager and is responsible for all marketing activities. Hoskin has been promoted to sales manager and is responsible for world sales.

Richard I. Knight has been appointed head of the Test & Measurement Group of Tektronix, Beaverton, OR.

Paul Dultz and **John Clemens** have been appointed to positions with Asaca/Shibasoku Corporation of America, Los Angeles. They both are service engineers in the technical support services department.

Ronald J. Ritchie has been promoted to executive vice president and chief operating officer with Ampex, Redwood City, CA.

Gregory Bedross is regional sales manager for BTS, Salt Lake City. He assumes sales responsibilities for the Northeast.

Dennis J. Nymeyer has been appointed West Coast regional manager at JVC Professional Products Company, Elmwood Park, NJ. He is responsible for the sales, administration and marketing efforts of the sales representatives on the West Coast.

Barbara Koalkin has been promoted to vice president of marketing for Digital F/X, Mountain View, CA. She is responsible for all of the marketing efforts, including the DF/X 200 integrated digital production system and the Composium digital production suite.

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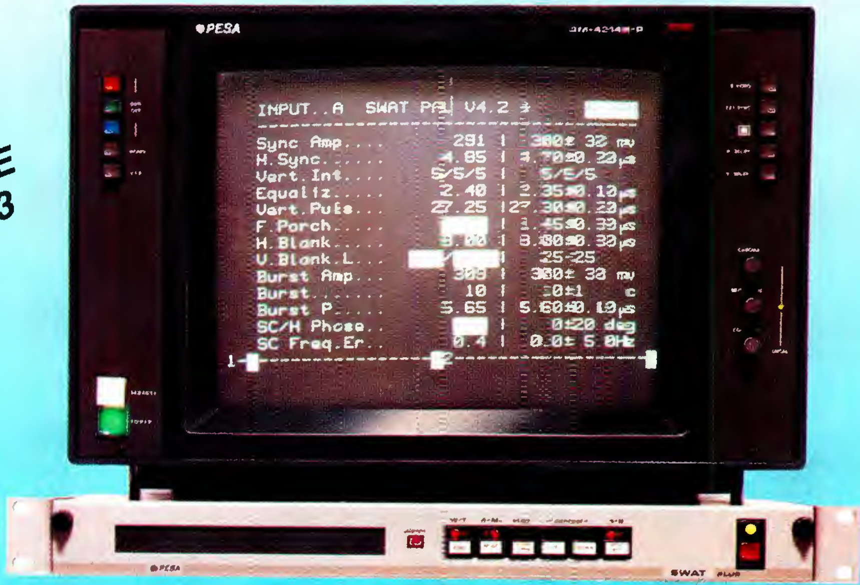

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- Number of Vertical Sync Pulses
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- Horizontal Blanking Width
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New products

High-resolution monitors

ASACA/ShibaSoku has introduced the following products:

- The 20-inch CM-93 and 14-inch CM-95 high-resolution color broadcast monitors. The grade 1 units use a fine dot-pitch in-line CRT with input facilities supporting NTSC, RGB, color-difference and Y/C signals as standard equipment. An optional auto set-up plug-in module is available.
- The VN30A color-video noise meter features luminance and chrominance noise, user-defined measurement functions and it supports NTSC or PAL standards. Measurements require only small areas each of uniform white and one color.
- The ADS-300 compact still-store system is based on magneto-optical technology. Storage of 1,600 frames of color video is done on one double-sided 5.25-inch disk. The system controller can support seven external dual disk drives, keeping 11,200 frames on-line.

Circle (350) on Reply Card

Component interfaces

Sierra Video Systems offers two S-VHS format converts. One uses RGB or Y/R−Y/B−Y to produce S-VHS signals. The other converts S-VHS video back to RGB or color-different components.

Circle (351) on Reply Card

Rack slides

Ergo Industries has announced Slidekits for use with rack-mounted Sony, Panasonic and JVC VCRs. The slides allow the equipment to be tilted and locked into positions for easier maintenance access without removing the transports from the rack.

Circle (352) on Reply Card

CD player systems

Pioneer Electronics has introduced models of single-disc CD players. PD-7300 is an 18-bit direct linear D/A unit. PD-4350 includes 4× oversampling with 18-bit emulating filters and twin 16-bit D/A converters. Coaxial and optical digital audio outputs connect to other system equipment.

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Setting the standard for High Resolution Broadcast Monitors, Barco Industries provides an intelligent choice with its CVS and CVM monitors. Both provide absolute color temperature stability (AKB) and excellent raster size stability. And both permit adapting to different video formats and new technology.

CVS Auto Setup Monitors, used by networks, major cable systems and leading production facilities, provide **total digital control** of all display and control functions in a Grade I monitor.

CVM High Performance Broadcast Monitors deliver full broadcast features, outstanding stability and exceptional brightness - all for less than $3,000.[1]

Barco Industries received the 1988 Emmy Engineering Award for its all-digitally controlled CVS monitor - the first broadcast monitor ever to be so recognized.

(1) Price at time of publication.

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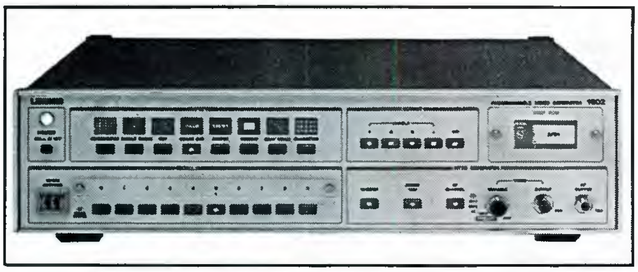
West Coast: (408) 370-3721

INTELLIGENCE RUNS IN THE FAMILY

Video generators

Leader Instruments has introduced two video-signal generators:

- The model 408 produces more than 80 test patterns in NTSC composite as well as RGB, S-VHS and Y/R–Y/B–Y formats.
- The model 1602 uses a PROM as its source of signals, generating high-resolution RGB signals at dot rates to 60MHz for any RGB monitor or video equipment.



Circle (354) on Reply Card

RF signal generators

Rohde & Schwarz has introduced the following products:

- The SMGU and SMHU signal generators for modulation measurements in radiotelephone networks. The SMGU range is 100kHz to 2.16GHz, while the SMHU covers 100kHz to 4.32GHz, both with a frequency resolution of 0.1Hz. Two hundred frequencies with various modulation and level settings can be called in a continuous sequence or from an external trigger source. The FM modulation range covers dc to 1MHz.
- The model SGMF NTSC signal generator produces 30 different precision baseband video signals based on 12-bit accuracy with IEEE-488 (IEC-625) bus control. The unit is available in different versions for SECAM (SGSF) and PAL (SGPF) with a synchronizer option for use in VITS insertion. For D-MAC and D2-MAC, the SGDF supplies four configurations of sound/data packets, but does not allow the synchronizer option.

Circle (355) on Reply Card

Animation controller

BCD Associates has introduced the BCD-5000 animation controller. Supporting RS-232/422 serial- and parallel-controlled equipment, the unit allows frame accuracy with videotape and disk machines. The system allows Macintosh, IBM PS/2, Amiga, Sun, Silicon Graphics and other computers to communicate with videotape and videodisk equipment more precisely.

Circle (356) on Reply Card

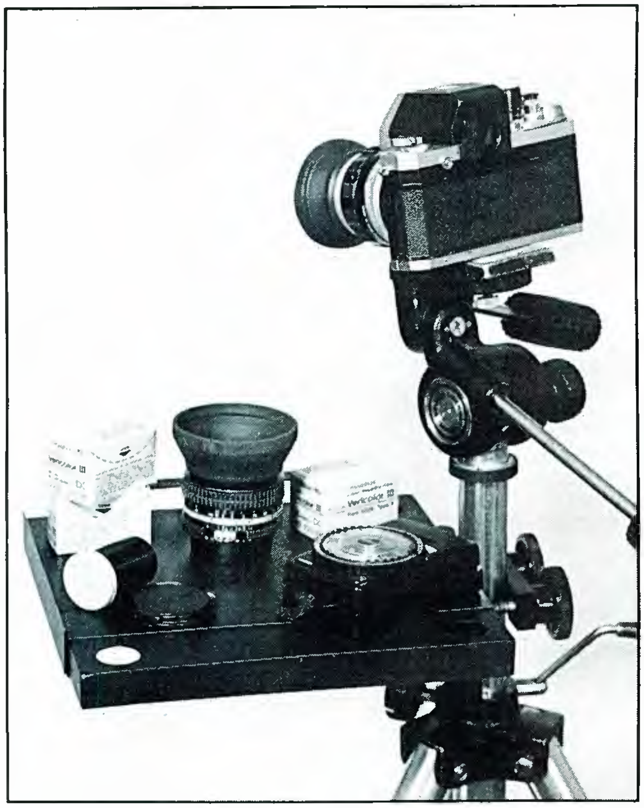
Software upgrade

New England Digital has introduced Version 2.1 software for the PostPro and direct-to-disk systems. This software revision, featuring EditView audio editing, uses Macintosh graphics to represent audio cues as blocks. By pointing and clicking the mouse control on a block, the editor can alter times/durations, fade-in/fade-out and volume envelopes for each event. The release includes support for the 2Gbyte optical drive allowing material to be dropped in direct from disk without first being sent to RAM.

Circle (357) on Reply Card

Tripod accessory

Technology Resource Group has introduced the Tripodtray. It attaches to a tripod to provide a 10″×14″ area supporting about 20 pounds of equipment from monitors to VTRs or lens/filter equipment. A cleat aids cable management. The unit remains fixed as the camera is raised or lowered.



Circle (358) on Reply Card

Digital FO system

Comlux and *C-Cor Electronics* have jointly announced a digital fiber-optic transmission system. It can be used for point-to-point and point-to-multipoint distribution systems for applications similar to multichannel transmissions in CATV trunk lines. Consisting of off-the-shelf components, distances to 40km can be expected without repeaters with no signal degradation.

Circle (359) on Reply Card

Tower sections

ROHN Products has announced seven foot sections for its 25G series towers in addition to 10 foot sections. The shorter sections continue to use the 12-inch face dimension, but can be shipped via UPS for faster delivery.

Circle (360) on Reply Card

Multiformat test signals

Magni Systems has announced the Signal Creator that creates a number of multiple format and standard test signals through the use of a wallet-sized memory card. Each card can contain as many as 100 test signals, while the test unit can accommodate five modules internally allowing a combination of NTSC, PAL, component analog and digital signal formats.

Circle (361) on Reply Card

Ferrite heads

Saki Magnetics has introduced a series of replacement heads for ITC audio cart machines as well as audio stacks for BVH-2000 VTRs. The replacement units employ ferrite material with glass bonding for improved head wear to 10 times that of conventional head material.

Circle (362) on Reply Card

Audio DA

Scantex Laboratories has introduced the ADA-100 dual-channel audio-distribution amplifier as part of the Super Transparent series. Six-outputs-per-channel accommodate a 115dB dynamic range for typical distortion of 0.01% at a +24dBu output level. Gain is programmable or remotely controlled through a 2-wire connection. Output short-circuit protection is provided. The Quad Metering System includes meter movements meeting ANSI-16.5 and BS-4297 specifications for VU and PPM metering. Balanced-bridging inputs on XLR-3 connectors offer high- or low-impedance selections.

Circle (363) on Reply Card

Dual RF modulator

Multiplex Technology has introduced the model 1020 dual modulator. It contains two agile modulator circuits per unit with completely independent controls. Operating on UHF and hyperband CATV channels, the units may be used in CCTV and inhouse video-signal monitoring systems, allowing tunable receivers to select desired channels.

Circle (364) on Reply Card

Lighting controller

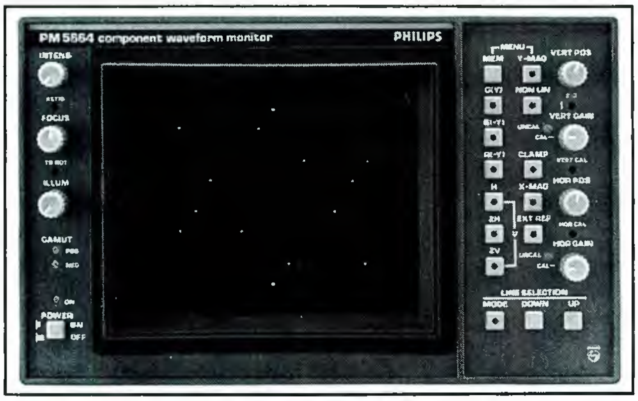
MJL Trading has introduced the PROROCK 60 light mixing desk, which offers 60 channel faders, 12 channels of effects and four channels of flash operation. Effects may include sound level, manual and other control options. Four master faders support grouping with programmed selection to any of the controlled outputs.

Circle (365) on Reply Card

Video test equipment

Philips PTV has introduced the following products:

- The PM 5643 analog component generator is programmable with a capability of 128 different test signals and monitor alignment patterns.
- The PM 5664 analog component waveform monitor produces a STAR display to show timing differences between luminance and color-difference signals.
- The PM 5682 RF converter accepts a TV IF signal to produce an output TV channel signal between 45MHz and 900MHz when used with a PM 5680 IF modulator.



Circle (366) on Reply Card

Video animation

Pansophic Systems has introduced Nimble, a 2-D video animation system supporting the Intel 80386 CPU, Truevision Vista graphics board, memory expansion and 32-bit signal processing. The system achieves a 1,024×768 pixel resolution and may contain up to 300Mbytes of hard disk capacity. Animation synchronizes to soundtracks through MIDI or Diaquest control.

Circle (367) on Reply Card

Signal supervisor, switcher

QSI Systems suggests the model 5700 as a unit to monitor program inputs for excessive noise or inappropriate signal levels. If levels or signal quality falls outside predetermined parameters, the unit switches to auxiliary sources until the original source signal qualities improve.

Circle (368) on Reply Card

Film scanner

Sondor has introduced the following products:

- The V12V/OMAS high-speed, continuous-motion color scanner for 16mm and 35mm film. Two separate optical systems including cameras avoid changing of modules and allow instant change of film format.
- The 8021 MK-II synchronizer uses time-code address sync, time-code pulse and control-pulse sync operation. The synchronizer serves as a time-code reader as well, and is used to keep perforated audio film in sync with videotape playbacks.

Circle (369) on Reply Card

Circle (109) on Reply Card

Circle (110) on Reply Card

Compact audio mixers

Yamaha Professional Audio has introduced several series of compact audio mixers including the MV1602 16-input mixer and MR series 8-, 12-, and 16-input systems. The MV1602 offers two mixing buses with four aux sends per bus. Inputs provide a combination of mic/line, line only and stereo capability. The MR units are 4-bus systems with a stereo master bus and all inputs offer electronic balance, low impedance, XLR or phone jack input connections.

Circle (375) on Reply Card

IC audio switch

Precision Monolithics has introduced the SSM-2402 dual analog T switch. It provides clickless switching over the 20Hz-20kHz audio range with signal levels to 10V. Available in a 14-pin plastic or 16-pin SMD package, the device maintains low distortion and noise, yet permits switching into low-impedance loads without buffering.

Circle (376) on Reply Card

DSK unit

Prime Image has introduced the DSK-601 component downstream keyer. The keyer is a complement to the S-Switch component production switcher, providing six component inputs with component and composite auxiliary inputs and an onboard colorizer. The unit allows keying and switching between the two video-signal source types.

Circle (377) on Reply Card

Audio processors

Solid State Logic has introduced the following products:

- The Logic FX G383 and G384 rack-mounted G-series electronics. The G383 unit is a dual mic amplifier with 4-band parametric EQ and low-pass filtering. The G384 module can be configured as a quad or stereo compressor with an auto-face function.
- The Synchronizer Controller, a bidirectional parallel interface between the G-series studio computer and a TimeLine Lynx Bus Supervisor. With the interface, the studio computer can control Lynx synchronizer modules.

Circle (378) on Reply Card

Lightning protection

Verite' specifies Veri/Protektor HC power-surge arresters to deter transients from lightning strikes to 200,000a. For power and data-line protection, these devices are designed to meet FAA navigational equipment requirements in single- and 3-phase versions.

Circle (379) on Reply Card

Digital A-V processing

Graham Patten Systems has introduced VAMP III, an audio-video multiplex processor. Two channels of CD-quality audio signals are transmitted through digital microwave or T-1 communications circuits.

Circle (380) on Reply Card

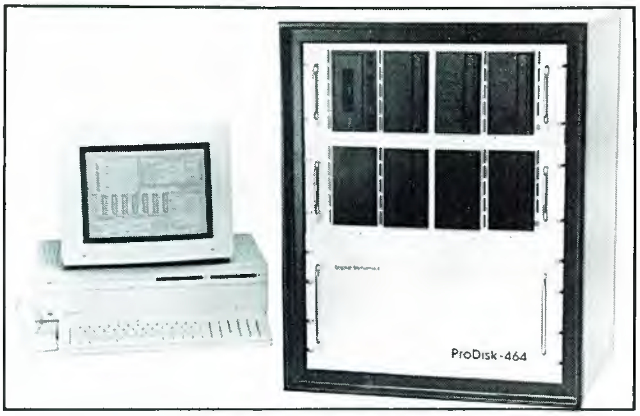
Video connectors

Nemal Electronics has introduced the NE842 crimp-type connector for use with Belden 8281A precision video cable. Type NE840 is used with 88281 plenum video cable. The tarnish-resistant devices have silver-plated contacts and Teflon insulation.

Circle (381) on Reply Card

Digital recording/editing

Digital Dynamics has introduced the ProDisk-464 digital disk audio recording and editing workstation. Both SMPTE timecode and MIDI-compatible, the system accommodates four to 64 channels with all control functions handled from a series of Macintosh screen displays. Plug-compatible with multitrack audio records, control features include reel-rocking and punch in/out functions. The operation is non-destructive in case a proposed edit is not suitable.



Circle (382) on Reply Card

Lens-control utility

Preston Cinema Systems has introduced MicroForce V, a zoom lens controller for various film and video camera lenses. Powered from the lens, the unit works with Ikegami and Sony cameras, providing external zoom and focus control. Remote VCR start and stop is included.

Circle (383) on Reply Card

Coaxial cable plug

Andrew has introduced an L44CW plug connector for use with 1/2-inch foam HELIAX cable. For LDF4-50A foam and FT4-50 high-temperature foam dielectric cables, the connector increases power-handling capability over N type connectors.

Circle (384) on Reply Card

Circle (111) on Reply Card

Circle (112) on Reply Card

Equipment racks

Studio Furniture has introduced a line of equipment racks. The Studio Module is 13-rack units high with an angled front for easy access to the equipment panels. The Studio Rack is 18-rack units high and slightly angled. The Studio Centre provides two 19-inch rack pedestals with a working top surface. Casters provide easy mobility.

Circle (385) on Reply Card

Routing switcher

DYNAIR Electronics has introduced the DYNA MITE, a 40MHz routing switcher. It is designed to handle NTSC, PAL and SECAM as well as all proposed ATV and HDTV signals and medium-resolution graphics signals. The switcher is flexible, able to handle video only, audio only or both aduio and video. The system is controlled from a built-in control panel or from up to 30 remote-control panels. It is compact and rugged enough to operate in a remote TV van.

Circle (386) on Reply Card

Local area video

Electro Communications Systems has introduced VideoLAN, a computer LAN system for displaying live video and sound as well as stored images on any workstation in the network. Image storage is based on optical disks, which provide a worst-case random access time of less than 0.7s.

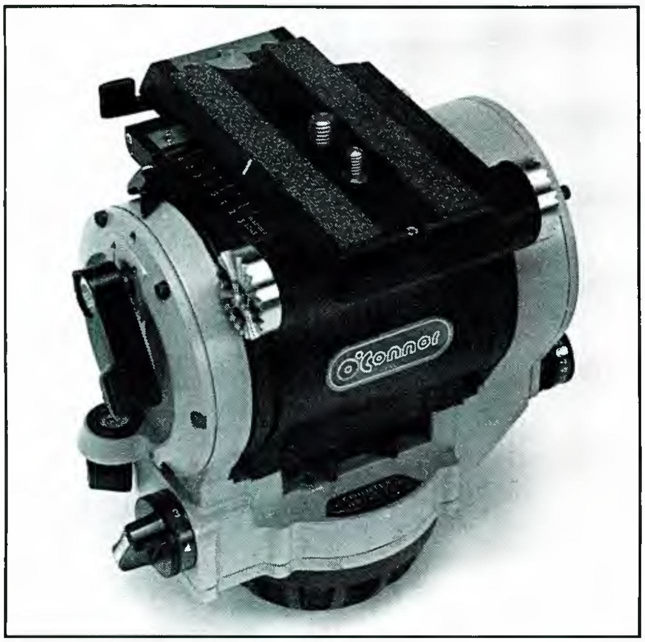
Circle (387) on Reply Card

Digital telecine

Rank Cintel has introduced URSA, a flying-spot scanning telecine using digital control of scanning as well as digital processing of the color video channels. The 4:2:2 system provides X–Y zoom and pan as well as rotation and perspective and an ability to curve and tilt images around X, Y and Z axes simultaneously and in real time.

Circle (388) on Reply Card

Fluid head support



O'Connor Engineering Laboratories has introduced the Ultimate 1030 fluid head. Constructed of aircraft-quality aluminum, the camera-support unit includes adjustable counterbalancing, ±90° tilt and adjustable/repeatable pan/tilt drag. The unit fits tripods with 100mm top casting.

Circle (389) on Reply Card

Score-reporting equipment

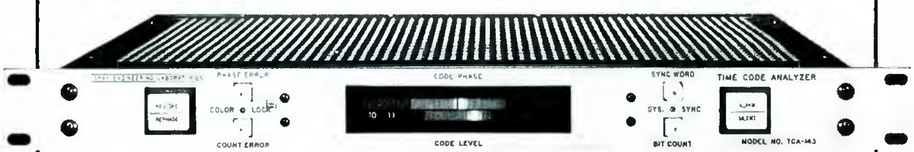
Telerate Systems SportsTicker Division has introduced Scoreboard, an interface between SportsTicker data via phone lines to a variety of character-generator systems. Developed by Dynatech Newstar, the interface operates on an AT or 80386 personal computer on MS-DOS, making scores and game results available for on-air presentation.

Circle (390) on Reply Card

Waveguide and switches

Micro Communications has introduced two parts for the transmission chain. The Coplaner Coax switch uses a high torque ac motor with integrated interlock and logic circuits, and also provides a manual override feature. The units are available in 1⁵/₈ inches, 3¹/₈ inches and 6¹/₈ inches. All are usable from dc to 900MHz, while the smallest size extends to 2,000MHz. The MCI Articulated Flex waveguide section provides single-axis movement in one plane but continues to solid support in the other two planes, avoiding compression or distortion of the waveguide. The waveguide can be configured for movement in either the H or E plane axis.

Circle (391) on Reply Card



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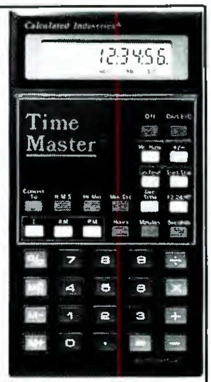
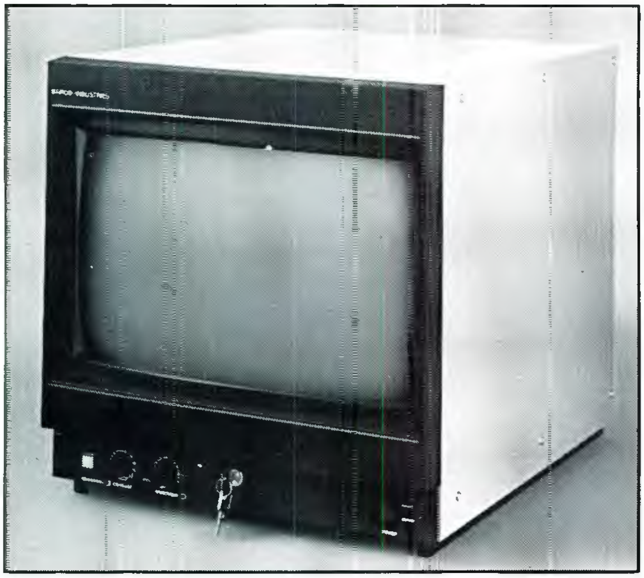


High-definition monitor



Barco Broadcast Products Division has introduced the HD-Monitor 5153. The 20-inch diagonal monitor displays 1,000-line resolution with all HDTV scan systems, 28-33.75kHz. RGB inputs provide compatibility with component processing.

Circle (392) on Reply Card

Wiring protection

Zippertubing has introduced several types of protective shielding as the type ZRP jackets. Primarily designed for flat, ribbon cable installations, shielding may include aluminum foils or flexible mesh of tin, copper and iron. A dielectric spacer is available to reduce crosstalk and maintain proper impedance.

Circle (393) on Reply Card

Composite signal processor

Somich Engineering has introduced the DBE-1000 dynamic baseband enhancer that increases apparent loudness and enhances low-frequency audio, while eliminating baseband overshoot. The stereo pilot and 67kHz SCA subcarrier are protected. In addition, processing removes common stereo aliasing at normal levels. Multiturn dials offer precise, repeatable control settings.

Circle (394) on Reply Card

Time manipulation

AMS Industries has released software for the AudioFile digital disk recording system. TimeFlex adds time compression and expansion capability, allowing recordings to fit into prescribed time slots. Reel-rocking simulates moving tape back and forth across the recorder head to locate edit points precisely.

Circle (395) on Reply Card

Inter BEE '89

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Tokyo Chamber of Commerce and Industry Bldg., 3-2-2, Marunouchi, Chiyoda-ku, Tokyo 100, Japan

Circle (8[illegible]) on Re[illegible]

Continued from page 155

TV-Sat 1, which was placed into orbit in 1987, but later abandoned because of a solar panel defect. Both satellites are the same make as France's successfully orbiting TDF1.

One reason for the broadcasters' concerns goes back to 1980, when France and West Germany agreed to launch identical DBS satellites based on the D2-Mac transmission norm. At that time, industry was unusually slow to develop the necessary chips for this technology. Another reason is that, with the failure of TV-Sat 1, German broadcasters were unable to lease transponders aboard TDF1. France chose instead to work with pay-TV broadcasters.

Although the West Germans were offered the opportunity to lease other transponders, they decided to wait for the successful launch of Kopernikus, a state-owned medium-power telecommunications satellite. Meanwhile, the government decided to upgrade Kopernikus to a telecommunications satellite with broadcast capabilities. Launched in June, Kopernikus may be transmitting all West German satellite programs by the end of the year. Because the programs are transmitted in the PAL format, viewers with 90cm-dish antennas can receive them directly.

SES finances Astra 1B

Luxembourg-based Société Européenne des Satellites (SES) has raised the funds to cover the launch and operating costs of Astra 1B over the next 18 months. Although the operation and location of the satellite have yet to be determined, much interest has been expressed in Southern Europe, where the signal strength of Astra 1A is reduced significantly. The satellite has been partly constructed from the Satcom K3, which was originally to be used by Home Box Office in the United States.

Grundig to develop HDTV components

West German-based Grundig, Europe's largest color TV set manufacturer, will assist in the development of memory chip applications at the request of members of the EC-funded JESSI (Joint European Submicron Silicon) project. Because of the chip-intensive TV technology of the future, the JESSI steering board plans to involve component suppliers and broadcast equipment manufacturers in the project from the beginning.

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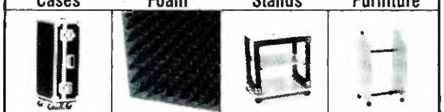

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TV MAINTENANCE ENGINEEER - Experience in studio equipment repair and maintenance. Strong Background in Sony ¾" and 1" Tape Machines required, UHF Transmitter Experience a plus. Send resume to Chief Engineer, KLAX-TV, 1811 England Drive, Alex., Louisiana 71303. EOE 10-89-1t

TV ENGINEER II Position for PBS station. Responsibilities include, but are not limited to, operating, maintaining, and repairing audio and video transmitting equipment, maintain equipment according to FCC Standards, logs of program transmittals, install audio and video patching systems. High School graduation or equivalent, two years of recent, full-time paid experience in television engineering. PREFERRED QUALIFICATIONS: Perform repairs and preventive maintenance on I.T.F.S. receive systems, in-house distribution systems, and translators, and install cable. Valid FCC General Class Radiotelephone License. Starting salary $12.33 per hour. Submit resume or an application by Tuesday, October 31, 1989, 5:00 p.m., to Support Staff Operations, Clark county School District, 2832 East Flamingo Road, Las Vegas, NV 89121. An Affirmative Action/Equal Opportunity Employer. 10-89-1t

ASSISTANT CHIEF ENGINEER—Rural Alaska AM/TV combo is looking for a self motivated person with at least 4 years experience in radio/television maintenance. Applicants should have valid FCC General or SBE Certification. Duties include maintenance on modern transmitters and studio equipment, system design and installation and limited administrative tasks. Salary DOE plus excellent fringe benefits. Send resume to Brad Humersine, C.E., KYUK AM/TV, Pouch 468, Bethel, Alaska 99559. FAX (907) 543-3130. EOE 09-89-2t

SATELLITE BROADCAST FACILITYseeks General Manager. Solid Broadcast Management background required. **NEW UPLINKING TELEPRODUCTION STUDIO** requires creative person with strong business, leadership and interpersonal skills. Contact: A.B.S. 6106 Lost Horizon, Austin, Texas 78759 FAX: (512)-345-1000 10-89-1t

"**WE'RE LOOKING FOR A CHIEF ENGINEER** for our AM/FM COMBO in the northeast. You'll need a minimum 5 years as a Chief or Assistant Chief. You must be familiar with AM Directionals, Digital Electronics, High Power FM, and Computers. We need a team player. State of the Art Equipment. Want to join a major group owner? Send your resume now to: Broadcast Engineering, P. O. Box 12901, Dept. 707 Overland Park, Ks 66212. EOE". 10-89-1t

CHIEF ENGINEER Growing opportunity in serene, suburban, college community 40 minutes from Columbus. Includes part-time asst. engineer. News/talk daytimer AM and Chr Class B FM equipped with new 25 kw FM and MW-1 AM. AM and FM have backup transmitters and standby generator with automatic switch control and lightning arrestor equipment on FM tower. FM covers approximately 50 mile radius with 60 DBU signal. R-Dat and CD music used in state of the art FM studios. Excellent processing chains on both FM & AM stations. FM transmitter building 3 minute walk from engineering room at WQIO/WMVO stations in Mount Vernon, Ohio. AM/FM part of a communications company which includes Mount Vernon Cablevision. Attractive salary plus benefits. Fine teamwork atmosphere. Please call Stephen, GM, at 614-397-2288. EOE/F-M.

BROADCAST ENGINEER Major Pittsburgh entertainment firm has an immediate full-time position available. Requirements include associate degree in related field, BS degree preferred. Minimum 5 years progressive experience in broadcasting or related communication field. Experience and demonstrated performance also required in one or more of the following: Videographer, CMX type editing, audio mixing and post production, or maintenance of GVG, CMX Ikegami 79 & 322, ADO, Sony BVH, BVW, BVU, etc. We offer a competitive salary commensurate with experience and an outstanding benefits package. Please send resume and salary history to QED Communications Inc., Human Resources Department, 4802 Fifth Avenue, Pittsburgh, PA 15213. EOE M/F/H/V 10-89-1t

TV MAINTENANCE ENGINEER The Christian Broadcasting Network, Inc., seeks an experienced TV transmitter engineer for assignment in the Middle East. Experience required in the installation, maintenance and repair of all television related equipment, including, but not limited to: TV transmitters, studio equipment, microwave and communications equipment. Minimum 3 to 5 years in broadcast TV electronics. If CBN's overseas mission excites you, send resume to: CBN Employment Department Box B 3, CBN Center Virginia Beach, VA 23463 10-89-1t

SHORTWAVE ENGINEER. Immediate openings at WSHB, WCSN, and KYOI - international shortwave radio stations of The Christian Science Monitor. One site in South Carolina, one in Maine,one in Northern Mariana Islands of western Pacific. Engineer is primarily responsible for operating, maintaining, and repairing high power radio broadcast equipment. Current FCC, SBE, or NARTE certification and 5 years transmitter maintenance experience required. High power experience preferred. Salary and benefit package highly competitive. Please specify sites of interest. EOE. Send resume to: Human Resources Administrator, The Christian Science Monitor Syndicate, Inc. 1660 Soldiers Field Road, Boston, MA 02135 Fax: (617) 787-6853 10-89-1t

CNN

TELEVISION ENGINEERS

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

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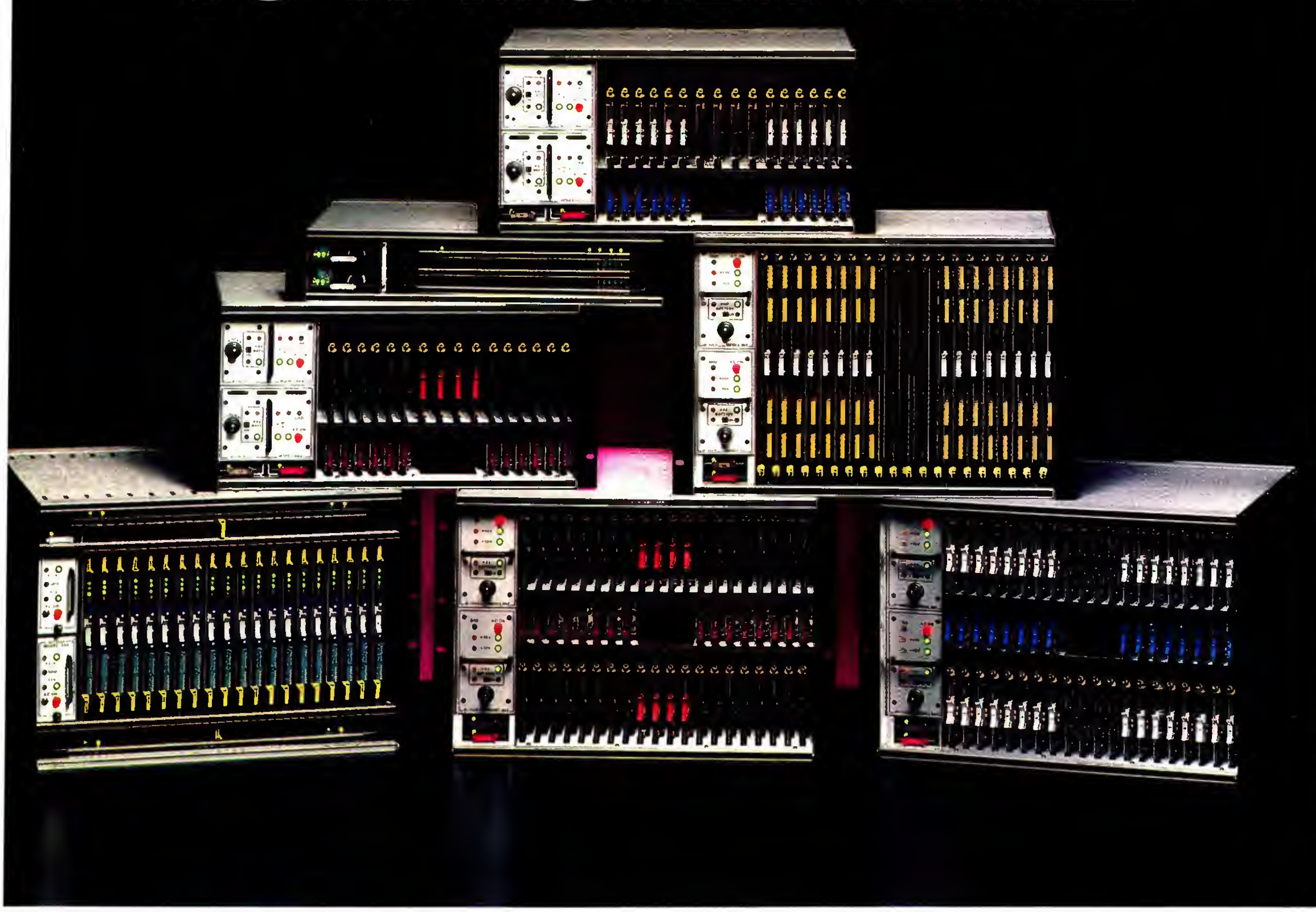

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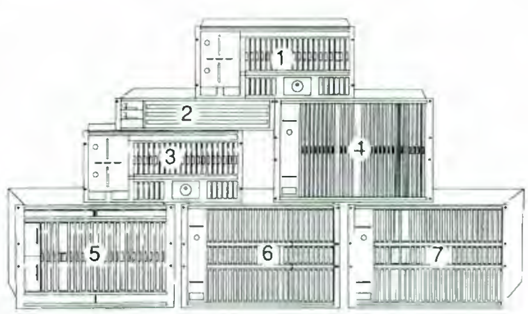

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