

# SOUND & COMMUNICATIONS

Volume 36 Number 6

June 15, 1990



## THEATER SOUND

### “KING”

The sound design of the musical in London's Picadilly Theatre required the use of some pre-existing equipment and the special demands of operatic voices. "Distribution is all," says sound designer Rich Clarke. **28**

### HIGH SCHOOL SOUND

High school theaters offer special challenges: youth, inexperience, and well-intentioned but equipment-damaging curiosity; severe budgetary constrictions; personnel turnover. How to make the job worthwhile—and do it right. **32**

### SYSTEMS AND FLEXIBILITY

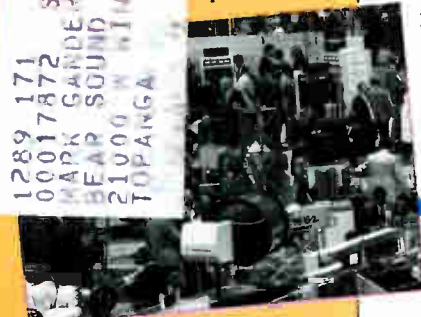
What pleases one evaluator annoys another. Some objectives are clear; others are optional. The proof is in keeping the client happy. **34**

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## MLSSA, PART TWO

We continue our hands-on review of DRA's MLSSA program, a decidedly valuable tool for easing the stress of sound design. **64**

## AMP TRENDS

It is universally acknowledged that the amplifier looks pretty much the same as it always did. But there are fast paced changes going on. The amp is now smaller, controlled by computer, has more functions, higher output and new design. This month we begin a series on Amp Trends, focusing in this issue on computer controlled amps. **42**

## HOTEL SOUND

Quality sound does business in the hotel industry. Going first class doesn't cost more in the end than second class systems. But the lure of a contractor's low bid may be strong. And sound doesn't work alone. Architectural and A/V considerations are worthy of input, along with computer control. **48**

## SOUND MASKING

As much sound masking is done by the furniture contractor as by the sound contractor. Why? And what's the size of this market, anyway? A report on common fallacies, truisms, marketing failures and successes. **14**





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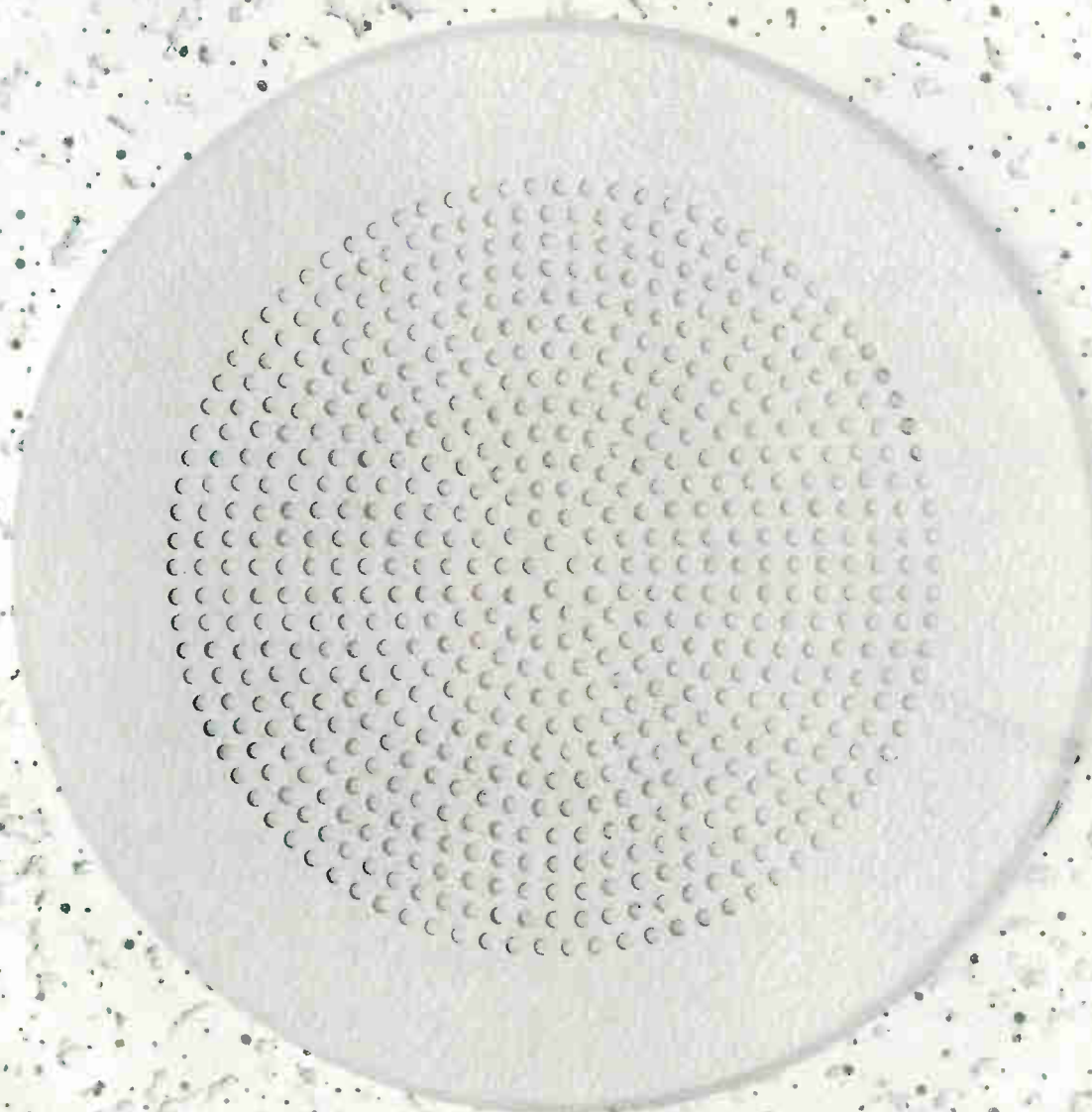
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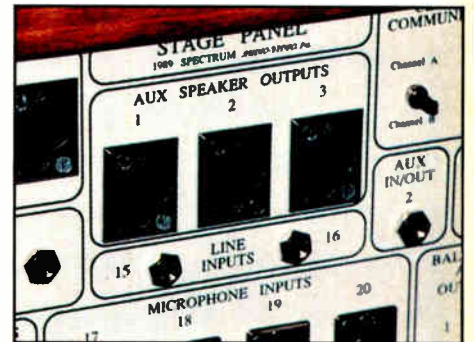
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The CD6020 consists of two 19" rack-mountable components—a control unit that can be mounted neatly in the mixer console, and a transport module that mounts in an equipment rack. This design ap-

proach enables sound contractors to upgrade existing club installations to CD without touching the turntables.

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World Radio History

# LETTER FROM THE EDITOR

**B**y the time you read this, the musical "King," which opened in the West End of London last week, may have closed. Those are the vagaries of theatrical endeavors. The preparations for any theatrical enterprise, however, require the same attention to detail and perfection — along with economy — whether a show will run for a day, a year or a decade. The controversy surrounding "King" involved conflicts among the producers, writers, and the family of Martin Luther King, Jr. There were objections to the lack of black personnel in the production of the play; other dallying to and fro took up time, and pushed the opening day back and back. In the end, all that becomes irrelevant. The show did open. And the reviews were decidedly mixed, not because of controversy, but because of the show itself.

None of this touched on the quality of the sound. The sound designer in a theatrical endeavor has a difficult job that isn't necessarily passed on to posterity. The sound designer for "King" was Rick Clarke who had to deal with pre-existing equipment, economic dictates of the producers, and unusual vocal qualities of theatrical performers. In this issue of *Sound & Communications*, we present Rick's view of the production and his job, including the details of equipment and placement.

Theater isn't always ephemeral. Some installations last for a very long time, and often are required to pass muster for very different presentations. Expanding on our coverage this month of theaters and auditoriums, we present a first person narrative by Bill Henderson, and an article by Chris Berger on dealing with the high school administration. High school theater design can, after all, be a lucrative business; most of the time, though, the sound contractor and designer is dealing with nonprofessionals with little experience in dealing with him.

No sound gets made these days without an amplifier. And no amplifier design is standing still. There are trends afoot that are changing the way in which we think

of amps. In this issue, we begin a series on amplifier design trends, beginning with "computer controlled amps." The amplifier has become Control Center of the new sound. The series continues next month with a discussion of proliferation of inputs.

Our special subjects are enhanced by many of the features we know our readers want. Mike Klasco continues his review of the MLSSA program, Chris Bunish writes on "hotel sound" and what's right with that market. And Allan Varela and Tom McCarthy review the NAB and NSCA conventions, respectively. We hope you enjoy this issue of *Sound & Communications*.

Speaking of the NSCA convention, it's our impression that most of the attendees came off it on a high. It's one of the very few business get-togethers we attend that seems to generate few negative comments. With little hype, lots of new products, and serious workshops, attendance in Las Vegas was well worth the time. We applaud NSCA's goal of strengthening the educational sessions even further next year.

NSCA-TV News was once again on the air with on-the-spot television coverage of NSCA Expo. Attendees were able to watch the news of the Expo on TVs in their hotel rooms and on a videowall and monitor on the convention site. Of course, NSCA-TV is written and produced by the staff of *Sound & Communications*; and we're proud of the news value of the program. We'll be following up in this and future issues of the magazine with print coverage of some of the hot products introduced in Las Vegas.

We hope you enjoy this issue of *Sound & Communications* magazine.

Regards,



Judith Morrison  
Editor-in-Chief

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# NEWSLETTER

## **ACQUISITION FROM ENGLAND**

Millbank Electronics Group Ltd. of England has become a wholly-owned member of the Security and Communications Group of Atapco. Other members of the Atapco group are Atlas/Soundolier, Javelin Electronics, and Northern Computers. Increased emphasis is expected to be made by Millbank on export of the company's line of professional and engineered sound communications and signal processing equipment to Europe and Asia. John Pownall, managing director, and all current staff and employees are expected to continue in their current assignments. The agreement was effective on May 1.

## **BOSE AT OLYMPICS**

Bose subsidiary Bose France has been named Official Supplier of Professional Sound Systems to the 16th Winter Olympiad in Albertville, France in February 1992. Bose will be responsible for design, supply, installation and maintenance of the sound systems for all venues at the Olympic games. Two local Bose contractors will execute the installations and maintenance. Bose France has begun the design work on the 24 installed venues.

## **HEYSER FOUNDATION OFFICERS**

The Richard C. Heyser Foundation has named Bart Locanthi president, John Prohs vice president, and Amy Heyser secretary-treasurer. David Andrews, Don Eger, and Charles Wilts have been asked to serve on the Board. The Richard C. Heyser Foundation was formed to administer The Richard C. Heyser Scholarship Loan Fund established to help deserving students pursuing graduate degrees in audio and related fields. Amy Heyser says the Foundation hopes to grant the first Heyser Scholarship Loan for the 1991-1992 school year. The address for The Richard C. Heyser Scholarship Loan Fund is 10415 Fairgrove Avenue, Tujunga, California 91042.

In related news, Version 4.0 of The PHD Program and a 109 page manual have been released by Ambassador College. The educational institution has granted permission to The Richard C. Heyser Foundation to give away copies of Version 4.0 as a means of promoting the Heyser Scholarship Loan Fund. Individual donors giving upwards of \$300 are sent The PHD Program "as a thank you." All donors who received Versions 3.x will automatically be sent the new manual and the update. According to Melissa Prohs, author of the program's manual, "Version 4.0 contains a number of significant improvements."

## **AES MORNING SESSION**

The Monday morning session at the AES convention in Los Angeles in September will include invited papers and attendance by noted acousticians including Dr. Manfred Schroeder. The session, organized by Sound & Communications technical editor Mike Klasco and Ken Jacob, chairman of the Technical committee on Acoustics and Sound Reinforcement, will deal with computer modeling of acoustic spaces. The seven-hour session is expected to deal with issues that foreshadow the computer programs that will be available to sound contractors.

## **NEW TEF**

Techron Industrial Products has introduced an entirely new TEF analyzer called the Tef System 20 Sound Lab. The System 20 is a one rack space package weighting less than 10 pounds which connects to a Macintosh or IBM compatible computer to form a complete measurement system.

## **HOTEL SHOW**

The International Hotel/Motel and Restaurant Show is celebrating its 75th anniversary in 1990. The show is scheduled in New York's Javits Convention Center November 10 through November 13, 1990. Attendance at the 1990 show is expected by the show's producers to exceed the record of 64,211 set last year. There will be more than 1,400 exhibitors.

# NEWSLETTER

## **WIRELESS IN PRISONS**

Elenex wireless intercom systems are now in use in state prisons where guards can freely patrol their area using a wireless headset instead of a hand-held walkie talkie. Elenex has been working with metropolitan areas to develop a new wireless intercom system with a special channel for security personnel.

## **INTERACTIVE SMITHSONIAN**

Pioneer Electronic Corp. donated \$1 million in audio and video product support for the recently opened Smithsonian Institution exhibition, "Information Age: People, Information and Technology." Pioneer's contribution included video monitors, projection monitors providing two-way touchscreen communication, and industrial LaserDisc players to store and play the exhibition's video information. In addition, Pioneer provided a twelve-cube multi-projection system, TAD professional speakers and a surround sound processor for the main theater.

## **CONVECTION SERIES**

The Crest Convection Series of "contractor amplifiers" has preamp and power module sections identical to the company's Professional Series, except that the Convection Series is one rack space higher and has external heat sink fins as opposed to the head sink "tunnel" on the forced air professional versions. The Convection Series is designed for fast heat dissipation with massive heat sinks, according to the company.

## **MUSEUM MARKETS**

Audio Visual Laboratories, recently acquired by The Alpine Group, is moving into new markets, including total environmental control of museum displays and retail point-of-purchase applications. AVL has added Super Genesis I/O and Super Switcher to the Super Family product line for presentation environment architecture.

## **EXPANDED LINE**

The Dukane Communications Systems Division, as a result of its acquisition of Poetker Communications late last year, is offering complete lines of communications systems including the new Dukane 2200 series console with intercom and program distribution for use on multiple room buildings, and the Telepax series merging telephone and intercom communications for institutional and industrial installations.

## **POSITION PAPER**

The National Council of Acoustical Consultants has developed a position paper on ATM Task Group's E06.51.06 Draft on Standard Specification for Rating the Acoustical Performance of Exterior Windows and Doors. Copies may be obtained through NCAC, 66 Morris Avenue, Springfield, New Jersey 07081.

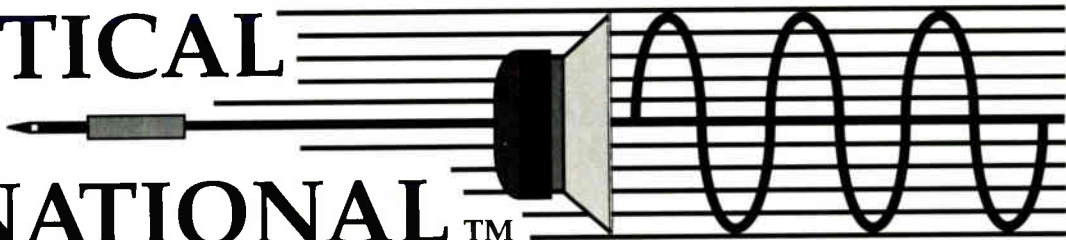
## **ROBOT ACQUIRES**

Robot Research Inc. in San Diego has acquired VCS (Visual Communication Specialists), developer of bidirectional transcoaxial communication systems and intelligent switchers. Robot Research produces digital video products and communication systems for the security industry.

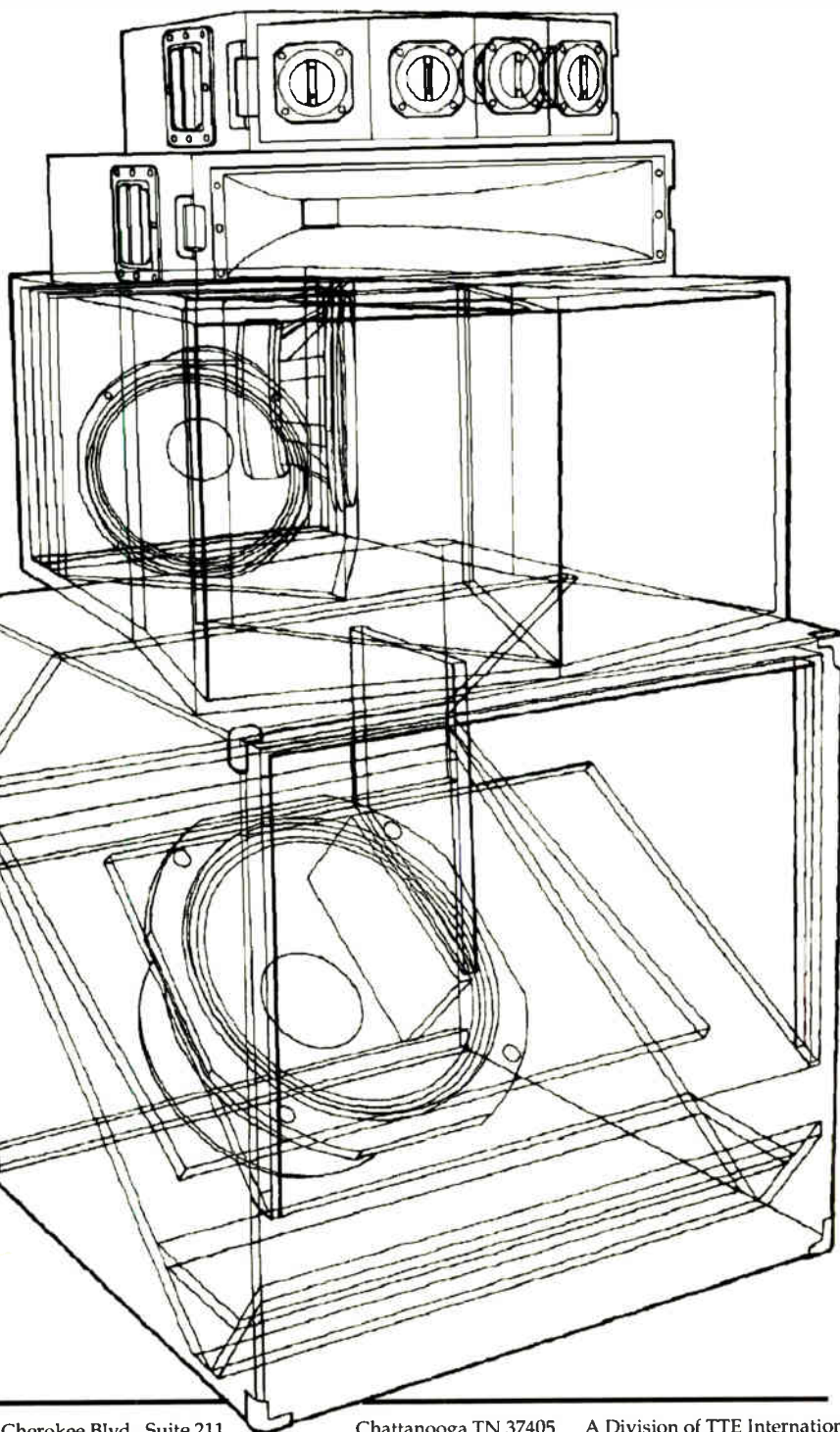
## **FAMILY OF PRO AUDIO**

Harman International has formally announced the addition of DOD/Digitech into the "H.I. family of Pro Audio companies." DOD/Digitech is a separate division of Harman International. Speaking on behalf of the parent company, Ron Means, president of JBL Professional, said, "This development represents a natural evolution in our long-term relationship with DOD/Digitech and will greatly increase our ability to offer and competitively market individual products in a worldwide marketplace. . . Current distribution of DOD products will remain intact."

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## The Marketing of Sound Masking

By Raleigh C. Perry

I have come across an analogy that I feel is representative of the basic problem that exists in the sales and marketing of sound masking equipment. Specifically, the analogy is this: Sound masking is to some sound contractors as chasing cars is to a dog. Once they get a hold of it, they cannot figure what to do with it.

Sound Masking, in and of itself, is construed by most sound contractors as a difficult concept. It is very hard for the contractor, since he does not work with it every day, to understand it, and almost impossible, on occasions, for him to explain it to his customers. How do you tell a customer that you are going to make his environment quieter by adding noise?

In a recent job being done by a dealer in my territory, that inability to explain the concept lost the job. In another job being negotiated by a large, very well known and competent contractor, the job was lost when the contractor determined with proper instrumentation that the noise level in the facility was already too high for masking, and he had to inform the customer that something would have to be done — wall and ceiling treatments, panels, etc., to eliminate noise before sound masking could be used. The frustrated customer killed the sale, stating, in essence, that if he was going to have to remove noise in order to increase the noise, forget it. The system was not explained properly by the salesman.

Traveling with salesmen for contractors, I see a lot of sales lost because the salesman does not know just exactly what

he is selling and why. Our role is to help explain the concept of sound masking along with the market size so that you can capture your share and do it right.

From a territorial perspective, most contractors do not know much about sound masking and attempt to stay away from it.

“How do you tell a customer that you are going to make his environment quieter by adding noise?”

My job is sales and marketing. But virtually no accounting system exists — no marketing research has been done to my knowledge — that can supply the necessary information. Therefore, I had to accumulate numbers from a variety of sources, ascertain what they thought their market penetration was, and arrive at a creditable annual volume. In addition to that, I had to talk to dealers all over the U.S. to ascertain what their usage patterns were to really come to the conclusion of what the actual dollar worth of the market is.

### ENGINEERED AND PRE-ENGINEERED SYSTEMS

Insofar as my job as a salesman and marketer is concerned, I would state (for simplicity) that there are two basic types of equipment on the market and each has its particular market, though, on occasions, their markets may overlap. Engineered systems are those systems that are designed by consultants, architects, and electrical engineers for particular structures, taking into consideration all of the acoustical environment that is to be masked. These systems require a noise generator, an equalizer, special speakers,

zoning apparatus (if necessary) and specialized adjustment by the installer. Many manufacturers make equipment that can be part of the system, some manufacture equipment for the whole rack, but, in general, the contractor or designer has a lot of sources of the needed equipment.

Several companies manufacture a box that generates the signal, appropriately curved, with some bass and treble adjustment available to adjust the sound to meet the needs of the acoustical situation. These will fit into the large number of installations.

Installation of either system requires some knowledge of the product and sound masking. Measurements have to be made with dB-SPL meters and, preferably, one-third octave, 31 band frequency spectrum analyzers prior to installation to ascertain the proper levels, and measurements have to be made after installation to make sure that the desired and most effective level is delivered. Most contractors possess the proper measuring equipment for doing the job themselves, but they simply do not know just exactly what they are supposed to do.

### SALES AND MARKETING

Who buys sound masking equipment and why is this far different and more difficult to surmise than what to install and how? In the past five years, I have been involved in the process of selling sound masking equipment in the southeastern U.S. To the best of my knowledge, there are only a few dealers who know how and to whom to sell the product and even fewer who know anything about it. For the most part, they are looking over Dodge Reports or have a bid from a potential user. At that point, they just go over the equipment lists available, meet specs insofar as possible, and, if they get the job,

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*Raleigh Perry is owner and operator of Raleigh Perry and Associates, Inc., a manufacturers' representative firm in the Atlanta area and national distributor of Hacoustic Sound and Communication products.*

install it and hope it works.

Who specifies it, why is it specified that way, and who installs it may actually surprise you.

For the most part, I have found out that most contractors do no specifying of the product. They leave that up to the electrical engineers, consultants, and architects and take the business that falls their way. In most of the southeastern cities that I service, I have found that the contractor gets only between one-quarter and one-third of the systems installed.

As a manufacturers' representative, I quickly found that attempting to sell sophisticated systems was too time consuming and worthless. The smaller systems, the negotiated job, seemed to be the way to go. One must still deal with architects and engineers to some extent but they can either be bypassed or sold by a more efficient sales organization. I presently have about a dozen contractors working on projects.

"For the most part, I have found out that most contractors do no specifying of the product."

I have found in quizzing contractors that their answer as to whether or not they would like to sell sound masking equipment is met with a response similar to "Well, I have only had two requests in the past five years."

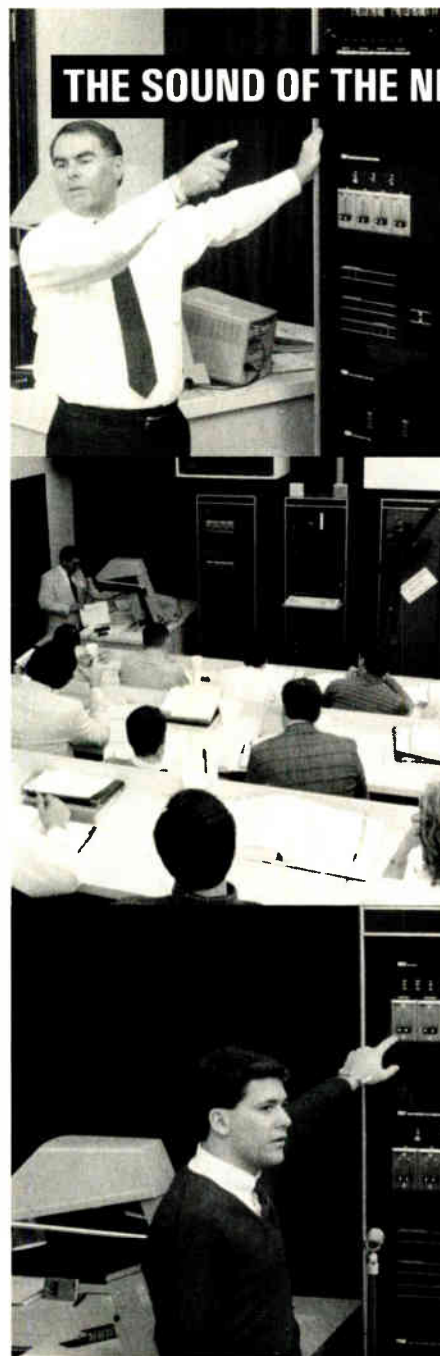
Contractors, I surmised, are not effective selling agents in this regard and I had to find an alternative route to selling the equipment. I found it! The market is somewhat open to sound contractors, but they will have to go beyond their normal calling routine in order to get the business. The business that they get will be primarily installation, but profitable, and will get them into more doors they never thought of entering for additional sound systems sales.

Specifically, I must state at this point that in my territory (and it may be a fluke)

as much as, if not more, sound masking is installed by contract furniture contractors as by sound contractors. This is more than true in Atlanta where a furniture dealer is doing the largest single percentage of the jobs and installs a system in virtually every office that he encounters, using the open office plan. These are the people who are in with the architect and

interior designer from the beginning, and they have a lot of influence.

The second largest dealer is a sound contractor very familiar with all of the particulars and capable of installing a system without the need of a consultant. This dealer installs more sound masking and could probably tell the manufacturers and consultants more about sound mask-



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ing than they already know, but he still is in second place to the office furnishings dealers by a good percentage.

### MARKET SIZE

According to figures that I have, and they are incomplete, the market size for engineered systems is probably about \$30,000,000 to \$35,000,000 net, without labor included, and not taking into consideration amplifiers used. This figure is considered conservative. (Amplifiers were left out because of the diversity of price, wattage, and quality that exists in the market today.) These systems are generally installed by sound contractors. From the figures that I have, I would estimate that approximately 3,500 of these systems go in with generators/EQ, speakers, wire, racks and amplifiers.

There are no specific data available on the "pre-engineered" systems, and I doubt that there will be because the list of manufacturers is small, and if only one gave out information, the remainder of the industry would be able to ascertain that particular manufacturer's market percentage. I would state with some assurance, however, that because these measurements are going after the market in a different manner that they may be more successful than the engineered systems. But after conversations with several of the manufacturers, I feel that I could be safe stating that the actual market size would come close to \$30,000,000 also and may exceed that. That would make the total market size of systems sold about \$60,000,000 or more.

These figures are only representative of equipment sold today at net prices to installing contractors, whether they are sound contractors or office furniture dealers. Most of the installations that are going in are going into buildings that are presently being built. There is a huge market in buildings already being used that have speech privacy problems. I think that I could positively state that the real market, at net prices (not including amplifiers on engineered systems) could well go beyond the \$80,000,000 to \$90,000,000 mark if contractors and

furniture dealers sold to all of their potential customers.

The general costs of a system, if you use an engineered system or a "pre-engineered" system, may run in the vicinity of 35—45 cents per square foot (without labor included), with the installed price running between 80 cents and \$1.50 per square foot. It can sell for as much as \$2.00/sq. foot. Pricing can vary away from those parameters depending upon the size and difficulties of the particular job.

**"In reality, there are no effective alternatives to sound masking, only adjuncts to it."**

It is interesting to note here that Sound & Communications Magazine, in its "State of the Industry Report," of 1988 never mentioned sound masking as a market. Contractors who were quizzed did not bring the subject up enough to make any category but "other." However, in 1989, the report stated that the most ignored category was sound masking, and that sound masking was the market on which most emphasis would be placed by those reporting contractors. It will be interesting to note just how the new report reads when it comes out later in the year.

In their report late last year where manufacturers were quizzed, very few manufacturers reported manufacturing equipment for masking. The 1988 Blue Book lists a category for Sound Masking but the 1989 does not.

Acoustical treatments is a category but few or none of the manufacturers of sound masking equipment appear in that listing. Most are relegated to other categories in the book.

### CUSTOMER BASE

Now who is the customer and how do we get to him. Customer bases can run from large corporate offices like the one I worked on in Miami with Steve Orfield, or to a psychiatrist with a doohicky on his desk to falsely take away any apprehension

from his client that their conversation can be heard outside the walls of his office. My list of good markets for sound contractors include libraries, open office facilities (bull pens if you must say it), and various government agencies (and you have to watch out here because many government agencies have their own criteria and those criteria may change region to region like it does with the IRS). There are other facilities that may need it, like museums, that you just have to locate on your own. Input from you on where they have installed facilities may be helpful here.

In talking to major contractors in my territory who have installed the most masking, I am left with the opinion that some possible markets that are not being approached are hospitals, larger psychiatrists' offices, large doctors offices, the recent innovation of medical centers (HMOS), mental health facilities, law offices, accountants, finance offices, banks and almost anywhere you can imagine that something is being said that does not need to be heard beyond the speaker and the intended listener. This is not always a market for the larger engineered systems but may be perfect for the "pre-engineered" system. Installation time is little and setting the equipment is easy. The market is, therefore, somewhat wide open and there are markets available for both engineered systems and "pre-engineered" systems. The best way, I think, for contractors selling into open office facilities is to retrofit the office. Furniture contractors tend to leave the facility after they have installed their furniture, leaving the sound contractor an opportunity to gain an entrance to the facility. The best entrance to this type of business is through the facilities managers' office. They quickly find out that without sound masking the facilities can be too difficult to work effectively.

### ALTERNATIVES TO SOUND MASKING

Sound absorptive panels may be considered by some as being a possible alternative to sound masking. That is not the case. These panels, manufactured by



A black AKG C568EB short shotgun condenser microphone is shown diagonally from the top right towards the bottom left. The microphone has a distinctive ribbed grille and a small switch on the side.

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several companies, are designed to bring down the noise level in an area. Sound masking, then, would be added to bring about speech privacy.

I do not have any figures whatsoever on the market for sound absorptive panels. There are many manufacturers, and most market basically the same thing, including fabrics with which they are covered. I will say that the panels are effective in bringing down noise — and expensive. More and more use of them is now being seen in churches, offices, school cafeteriums and gyms. These are used more in conjunction with masking, not as replacements. However, they can be used to bring down noise in any environment without the concept of masking being added. The market is broad, and growing.

Background music is also considered by some to be a masking alternative. It is actively sold by its dealers as having that

capacity. However, the frequencies of the music do not have the depth in the areas necessary for proper speech privacy to serve a real purpose. Often music is run over the masking system speakers along with the masking noise. This, in my opinion, is the wrong way to handle the mixing of the two sound sources in an environment. Music should be put into speakers mounted on the ceiling panels in the normal manner and masking speakers should be mounted in the plenum area. Music played through masking system speakers has to come through the ceiling panels and, thereby, will have its quality muted by passing through the panels.

In reality, there are no effective alternatives to sound masking, only adjuncts to it.

### SELLING

Sound contractors most often do not

take the time to “sell” their services. They wait until the phone rings or the Dodge sheets come in and act appropriately. Sales can increase with proper use of salesmen. That, specifically, is how the Muzak and other background music dealers got into the sound contracting marketplace. They have salesmen on the street selling music service. Any ancillary sales of sound systems is pure gravy for them and helps with the cash flows. In Atlanta alone, because of a new attitude under new leadership, the Muzak dealer has moved from obscurity to, perhaps, the third largest sound contractor in the area because of the employment of a good sales force and good sales management taking negotiated jobs that other sound contractors never even know go down. You can do it, too, with the proper steps. The first step is not to wait for the customers to call you....PROSPECT!!!!

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## A Personal View of NSCA Expo '90

By T. G. McCarthy

**L**ook forward to the NSCA Conventions perhaps a little more than to the other audio trade shows because I'm a sound contractor, and NSCA does a particularly good job of communicating within my field. This year's show, at the Las Vegas Hilton, April 19-21, was a good example. The exhibits were solid, the educational programs timely, and fluff and flimflam seemed to be held to a minimum. Compared to the other electronic communication industry shows, NSCA is low glamour; it's not the place to see keyboards, guitars or the latest one-of-a-kind console. The discussions tend to be applicable rather than theoretical and the hardware tends to be practical rather than whimsical. I suppose the reason for that is that sound contractors are practical sorts of people.

Broadcasters and recording studio operators can afford to make major financial and engineering commitments to untried equipment. They generally have in-house resources and the wherewithal to deal with idiosyncrasies (and to do redesigns if necessary). If they need to, and if doing so will keep them on the leading edge in their market, they can even change their mode of operation to mesh with the new technology. That capability, coupled with the incentive to make a piece of untried equipment work which comes with having spent, or recommended spending, the money to buy it, makes "Gee-Whiz" technology viable there, where it is not viable in sound contracting.

A sound contractor does not live with his installation on a daily basis. He or she has to be able to put the system in and then walk away from it, turning its operation over to someone else. Because the system may serve a support function rather than being central to the owner's focus, the operator is often someone with



*Past and present presidents Mel Wierenga (left) and Jay Johnson.*

no particular skill or interest in the technology or the art of using it. The system may be incidental to what the owner wants to accomplish, but nonetheless it may be vital to smooth work flow: The factory paging system that everyone uses continuously, for years on end, never giving it a thought, can cripple the plant when it fails. An alarm that doesn't sound can be devastating. The auditorium sound reinforcement system that doesn't let the wisest person in the world get the message to the members of

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the audience can cause the meeting to be considered a failure.

For these reasons, sound contractors tend to look for solid robust design rather than glamour, and for practicality rather than whimsy or hypothetical musing. And that's where the flavor of NSCA is different from other trade shows.

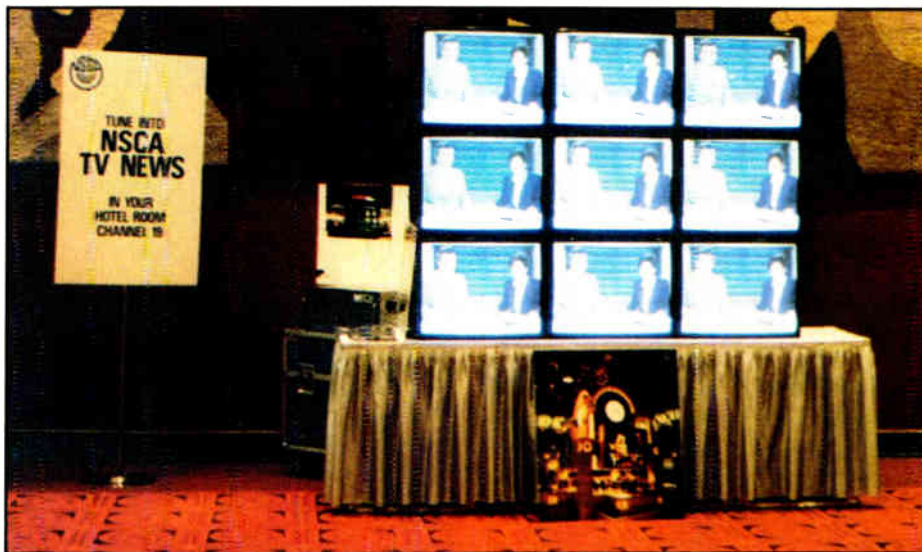
Walking through the doors of the exhibition area, my first impression is that it is massive and packed — both with exhibits and with attendees. I can tell it is a sound contracting show. All the staples of the industry are here: wire, racks, panels, loudspeaker ceiling grilles, fasteners, ... the familiar nuts and bolts stuff that are apt to go into any installation. Many of the exhibitors are companies that have supplied sound contractors since before they were even called sound contractors. There are a lot of newer companies too, some of them founded by sound contractors who are marketing products that they developed to meet their own needs.



*The Expo was packed.*

My main interest is in sound reinforcement, but security, nurse call, doctor call, video, intercom, RF data link, background music, projection, paging, central clock and test equipment contingencies are well represented too.

There are several companies showing innovative remote control systems; some



*NSCA-TV News was on the air.*

that let the chairman give a presentation using video or a few slides without looking like an incompetent idiot in his own board room. Others make it possible for a hotel house person to successfully reconfigure the sound distribution in a multi-use ballroom in his second day on the job. Other equipment is shown that takes some of the complexities out of teleconferencing and multi-lingual interpreting. A lot of the new equipment is computer driven, but you don't have to be a computer whiz to use it.

These days many of us are interested in flying loudspeaker clusters, and many of their producers are on hand. Most of them are prepared to discuss the safety and engineering aspects of hanging hundreds of pounds over people's heads. Some of the exhibitors even have cutaway cabinets or other ways of demonstrating that stress lines are carried safely from hanging point to hanging point.

For those of us who like to build our own arrays and clusters, there are plenty of horns, drivers and low frequency boxes. For those who don't, there are pre-built flying loudspeaker systems that are optimized for say, churches or arenas or other specific types of rooms. For those of us who are in between component level and pre-fab clusters, there are cluster modules. A system designer simply fits the modules together to get the shape of cluster he or she wants.

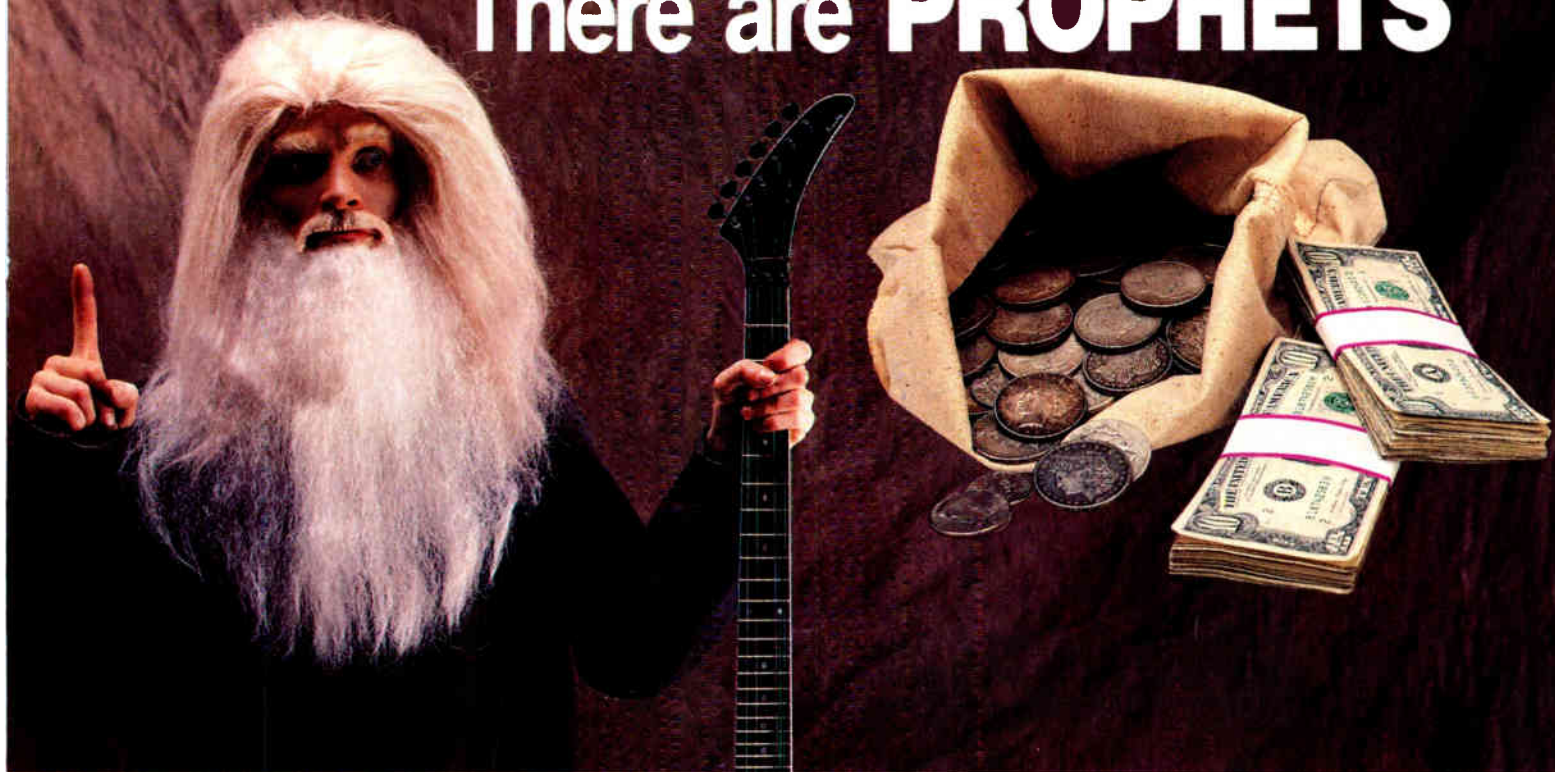
This is a good place to check out the hardware. The quality factor is high and the baloney factor is low. There is a little snake oil being peddled and perhaps a dog and pony show or two trying to wear cloaks of legitimacy, but all in all the laws of physics are seldom being repealed and magic equipment representing instant solutions to all problems is very scarce.

A few things that caught my eye are:

- The Modular Audio Processor (MAP) and Logic Controlled Amplifier by Lectrosonics, Inc. These items may represent a solution to tricky conference room reinforcement and teleconference distribution problems.
- OAP's line of flyable loudspeaker systems, particularly C-1, a system put together based on a polling of sound contractors, specifically for churches.
- KDM Electronics, Inc. Off the shelf arrays.
- The new 'TEF System 20 machine. The old "prototype" looking box is gone, replaced by a set of disks and an interface box for your favorite IBM compatible or Macintosh computer.
- The Yamaha S1520S loudspeaker. Especially noteworthy is the soft cornered mid-range horn. Haven't seen specs on it, but it sure sounds good and it intuitively looks right.
- Altec's VIR and VIT asymmetric horns.

Some of the demo rooms suffer the

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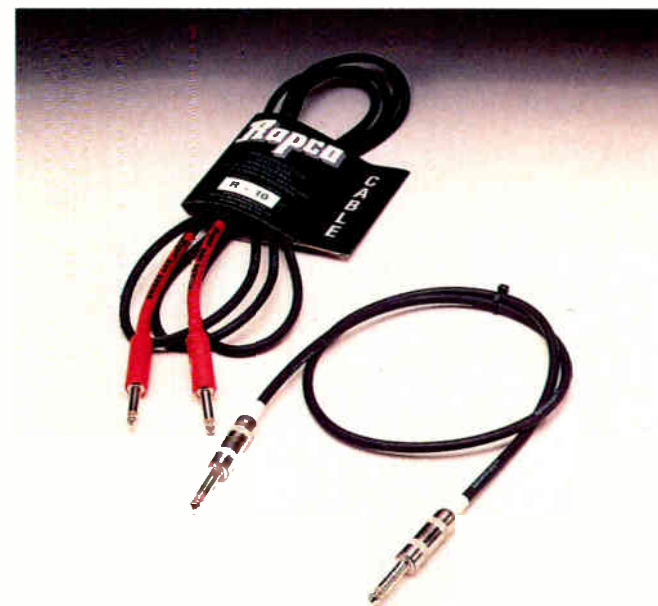


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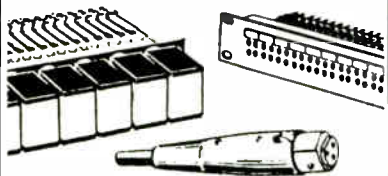
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## NSCA EXPO

same problems demo rooms often seem to suffer — excessive sound pressure levels and excuses from exhibitors about poor room acoustics. I combat high levels by leaving as soon as they go above what I judge to be 90 dBA. I don't have much patience for excessive distortion either. I can, however, tolerate poor room acoustics, if that's really what the problem is.

In talking to attendees of the education programs, I find the comments are very positive. The programs seem to represent a good division among technical, sales and management how-to sessions. That a few attendees criticized the sessions as too specific and a few others as too general would seem to indicate that the topics were generally on target.



*General Manager Mary Beth Rebedeau speaking to NSCA attendees.*

One of the main reasons I go to an industrial show is for the chance to talk to the people. NSCA is particularly good for that. People here seem a little more open and less defensive than at other shows (or maybe I have better luck falling into the right groups here). At any rate, I've had more objective give-and-take conversations at NSCA than at any of the other trade shows. I think part of the reason for that is that people here have actually been on the front line. They don't care how many angels can dance on the head of a pin, but they do like to talk about real problems and their solutions. The war stories alone make the trip worth while.

One of the things I am particularly interested in is the opening of discussions with people in the computer aided design (CAD) industry regarding interfacing standards between professional CAD programs



*NSCA's Executive Director "Bud" Rebedeau.*

and sound system design programs. [During the NSCA Expo. *Sound & Communications* magazine hosted a meeting of the major players in sound system design in order to open just such a discussion. — Editor] If interfacing can be accomplished, it is foreseeable that someday we will get our blueprints from architects in Auto Cad, Generic Cadd or some other CAD file on computer disk rather than paper, and that



*Many got a chance to see some new products for the first time.*

data they contain will flow right into our sound system design programs. That accomplished, we could conceivably go through our audio design routine, add our new information to the blueprint data file and send it back to the architect. Coordinated system designing without lifting a T square, or manually translating data. What next? Push-button installations?

Well, here's looking forward to next year's NSCA Expo. ■

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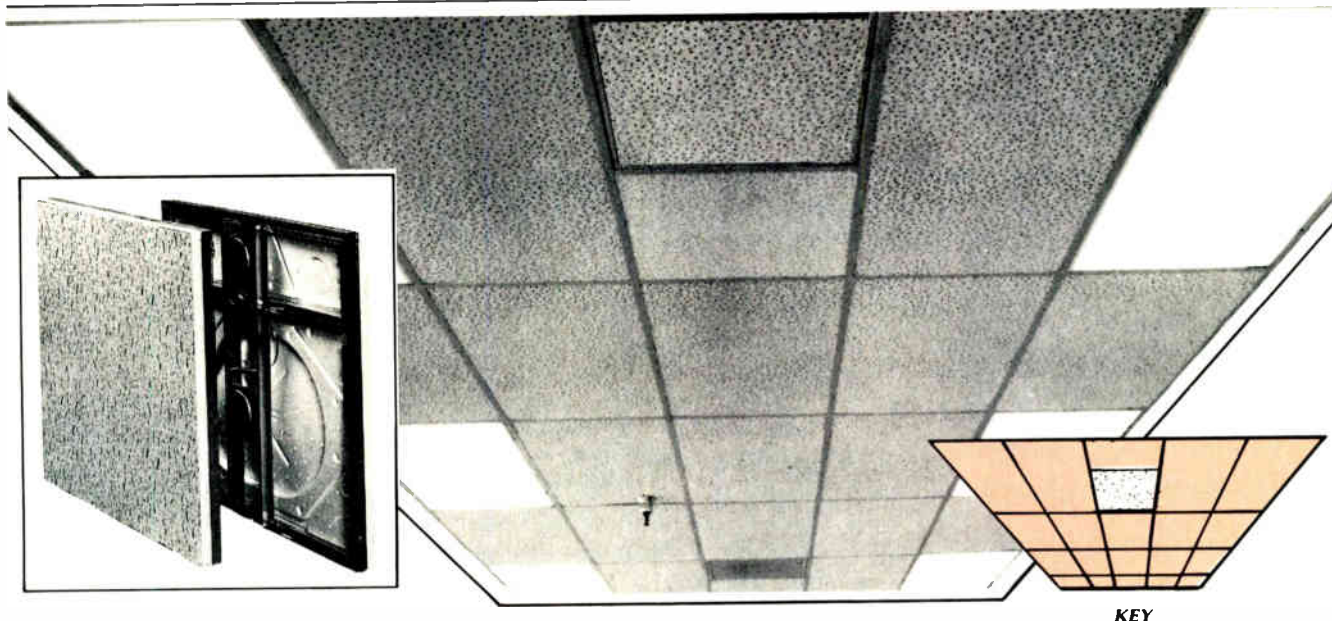


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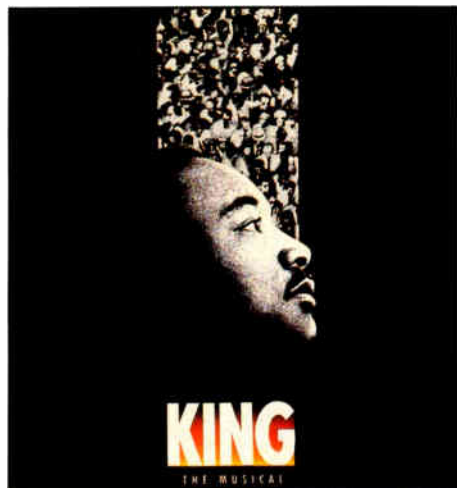
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# KING — THE MUSICAL

BY JENNIE DODD

**A**mid much back-stage controversy, “King,” the new musical by Richard Blackford with original lyrics by Maya Angelou finally premiered in London’s West End on April 23rd.

This major British production celebrates the life and achievements of civil rights campaigner Martin Luther King Jr. We asked sound designer Rick Clarke how he approached the production:



King was a challenge from the start, because unlike other musicals I’ve been involved with, this was an unusual blend of operatic voices, a 21 piece orchestra and a rich and varied score which made full use of a strong rock and roll rhythm section. My first instinct was to go for a gentle reinforcement approach rather than broadcast system to achieve realistic “imaging” on stage, but with this particular orchestral line-up straight reinforcement would not have been adequate. The agreement I had with the producers was to use a rig that they had utilized previously on “A Little Night Music.” This obviously was a major constraint and one that I had never faced before, but I was happy to accept the job on this basis because I always try to promote the role of sound designer in the way, that lighting designers work in theater.

That is, a good sound man should be able to work with any competent, professional equipment and make it work his way.

My basic approach to sound in theater is that as far as possible it should be imperceptible. Distribution is all, without removing the feeling that the sound is coming from anywhere other than the performers. Also that all the audience can hear the show equally, irrespective of seat location. This view also encompasses distorting the natural dynamic and ambient qualities for dramatic purposes.

The speakers supplied were Turbo-sound TSE111 and TSE115 with BSS crossovers, C-Audio amps and a DDA Q-Series 40 input desk. I’ve never worked with any of these products before and I discovered that the best way to treat the TSE111 box was as a 30-degree by 30-degree dispersion unit. I would have liked VCA control on the desk. The band line-up consisted of a six piece string section, four piece brass, four piece reeds, percussion, kit, guitar, bass, and six synthesizers played by three people. My first task was to contain the orchestral sound. I was helped at the Picadilly Theatre by an existing soundproof room on stage right. I arranged for the synthesizers, bass and guitar to be in this room where they could monitor at their accustomed levels without causing spill problems. The pit did not have enough room for the rest of the orchestra, so to make space we removed a set of doors between the understage area and the pit, and replaced them with two sheets of plate glass to create an area for the drummer with visibility and line of sight to the musical director. This drum booth had to be soundproofed as all the show’s hydraulic motors were located in this understage area; their noise had to be excluded from the open drum mikes. Radiused reflective surfaces were used within the room to keep a live, bright feel to the drum sound. This left the pit with



*The Picadilly Theatre in London’s West End.*

only natural acoustic instruments. Further screening and an application of mineral wool attenuated the brass and percussion.

For front of house I have always used a distributed cluster of speakers above the proscenium arch and looking at an earlier model it was good to find that a technical bridge had been planned, large enough to house these speakers with ease. However, during the last weeks of rehearsals this, along with many other major production details, was altered and became, instead, a very large tree whose trunk ran up the stage right proscenium and whose leaves and branches encompassed the whole of the arch! I had planned to install 9 TSE111 speakers (3 for each level) and 6 TSE115 speakers (2 for each level). These now had to be deployed within the tree and yet still

see the room. After much deliberation the speakers were finally "lost" in the structure of the staging and still proved effective.

On the arched sides I decided to add Community's 327i box supported by Turbosound's TSE118 sub bass to provide wide enough dispersion without overcrowding. The rest of the front of house system included Bose 101s along with pit rail, 2 lines in the under balcony area of the stalls and 2 lines in the under gallery area of the circle. These were there in order to provide cover where the main system is shaded by the balcony and gallery. I used two full range boxes placed on the rear wall at every level for special effects. In total the actual number of speakers employed front of house in this production is 57.

On the console side, the 40-input DDA Q driving into an AHB 8 x 8 custom matrix mixer is supported by a 24 input DDA Q and 2 TAC Bullets. Two NAB carts and 1 RS DAT provided tape replay, and for effects, there is an AKG ADR 68 K for main vocal reverb, a Yamaha Rev 7 for orchestral reverb, SPX 900 for kit effects, an Alesis Midiverb to add a small amount of reverb to vocal fold back and Roland Dimension D to fatten the strings. For time delay an AKG TDU 8000 and 2 Klark-Teknik DN 716 units are used. For equalization 10 channels of Klark-Teknik 3rd octave graphic equalizers, and 1 Yamaha DEQ 7. Also used are 1 KT quadgate, 2 KT quad compressors and 1 KT dual compressor expander to help keep out the spikes and buzzes. The compressor expander proves very useful in containing the very wide dynamic range of the operatic voices.

My approach to fold back on a musical stage is to provide orchestral fold back to the stage sufficient to give all performers their musical cues, and no vocal fold back. The reason for this being if the level of sound on stage is kept to a bare minimum, then the need for cross stage fold back is obviated. This has the secondary beneficial effect of cutting complaints from the company about the fold back altogether during the run of the production.

There is always enough spill from the

wings and front of house to provide enough information on stage. As a good proportion of the performers were from opera, I thought this would easily be achieved. The fold back on stage is 4 E-V S200s, 5 Galaxy Hot Spots and 2 Turbosound TFM 212s. Fold back to the orchestra is rather more complicated and involves 5 Yamaha

MV802 line mixers plus 17 Galaxy Hot Spots and two further TFM212s. In the Amp room there are 25 stereo amplifiers from C-Audio, Soundcraft and Yamaha.

The method I use for setting up a front of house rig is to place a small speaker on a mic stand up stage center on the apex of an equilateral triangle with the pro-



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scenium opening as its base. I then relate in time every speaker in the auditorium to this point. This, providing certain dynamic parameters are maintained, achieves accurate imaging for both performers and orchestra.

“The opera singers were finding it very hard to judge their dynamics.”

The next part of the setup procedure is to equalize and balance each element of the rig. For this I used the dbx RTA 1 analyzer and a wide range of music and



The sound booth at Picadilly Theatre's production of "King."

vocals on CD, as well as having assistants walk about stage talking into radio mics. We used 20 channels of Sennheiser Diversity radios, 5 in VHF and the rest in UHF: 18 for the performers, and two for stage management communications.

The unusual problems encountered on this show came largely from the opera singers. My mistake was to forget that opera singers do not normally perform eight shows a week in open ended runs, and would therefore have to sing down from their normal levels to protect their voices. This, coupled with the distortion of the natural dynamic that an amplification system provides, meant that they were performing in an alien acoustic environment. In unamplified opera it is easy for them to hear reflections of their voices coming back from the house. Now with music and other performers being amplified, they were finding it very hard to judge their dynamics. The only way round this was to give the opera singers a small amount of gently reverbed vocal fold back.

("King" has sensitive performances backed by some excellent new musical material and innovative choreography. However, it did not meet any great critical acclaim on its first night, and it remains to be seen how long its London run will last and whether or not it is destined for Broadway.)

**"King" Credits**

Music by Richard Blackford  
 Lyrics by Maya Angelou with additional lyrics by Alistair Beaton  
 Book adapted by American playwright Lonne Elder  
 Designed by Timothy O'Brein  
 Costumes by Lindy Hemming  
 Sound Design by Rick Clarke  
 Lighting Design by Robert Bryan  
 Musical Director Fiz Shapur  
 Musical Supervision by John Cameron  
 Orchestrations by John Cameron and Richard Blackford  
 Choreography by Dianne McIntyre  
 Directed by Clarke Peters  
 Martin Luther King: Simon Estes  
 Coretta Scott King: Cynthia Haymond  
 Producer: Hans Flury and Peter-J Hargitay  
 Peter Wilson for H.M. Tennent Ltd, executive producer

**Rick Clarke Biography**

Rick Clarke's career in sound began with rock and roll. He was then a director of a sound hire company before joining the National Theatre in 1980 as senior sound technician. In 1984 Rick started his solo career as sound designer with the award-winning production of "Me and My Girl," followed by the award winning production of "The Hired Man." Rick has gone on to design the sound for over 50 West End shows and tours including "Brigadoon," "Sugar Babies" and "Evita." In 1988 Rick diversified his company, The Sound Department Limited, which now also imports and distributes some major U.S. product and specializes in overall system design for large U.K. pro audio contracts. Some projects on hand include: Earls Court Exhibition Centre, British Petroleum Hamble, and a leisure attraction in Weymouth, Dorset. New theatrical productions Rick is contracted for include "Show Boat" at the London Palladium, the new U.K. version of "The King and I," and a new musical version of "Around The World in Eighty Days." Rick is currently in Japan designing the sound for South Pacific.

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# HIGH SCHOOL THEATER: AMATEUR OPERATORS MIXING PROFESSIONAL AUDIO

BY CHRIS BERGER

**A**t first glance, amateur operators mixing professional audio seems to be a contradiction in terms. After all, if the operator is not a professional, then why put the controls in his hands? Why not install an automatic mixer, or provide a rental front-end system and operator?

Well, there is a way to give up the controls without giving up your reputation. However, it does require a little "home-work" when designing theaters for high schools.

## GETTING THE BACKGROUND

An experienced designer knows that whoever he's building a system for, he needs background on the facility, its uses, the people who run it and those who run the sound system. Background research on a high school facility can prove to be different, however. One of the key differences from professional production venues is that, like churches, there often is no real plan for the types of productions to be held over the next five or 10 years. This means: a) you help them think these things out, or b) you assume they'll call you if their system needs an upgrade. Well, we all know what happens when we "assume."

To research the uses of high school theater, I start with the supervisor for the facility. There are additional sources for information:

There is a good chance you will be asked what types of events your sound system design will support:

**School Activities:** theatrical productions; band and choir concerts; guest speakers; speech class; theater audio and lighting class; school oriented seminars; talent/variety shows.

**Community Activities:** church functions; national guest speakers; community-oriented seminars; professional training classes; beauty pageants; summer theater workshops; national act concerts (This has been proven to be quite successful across the country; however, the client should be aware that supplementary rental production equipment is often required.)

A theater supervisor may say, "We only use our theater two or three times a year for plays, so let's keep this thing cheap and simple." At this point we can either accept his position or spend a good deal of time educating him and/or his superior. Negative responses to technology are often based on fear. Fear is conquered by education.

Keep in mind that this person may not be here next year. It's always a good idea to schedule a one-on-one with his superior, who is usually the school principal. His annoyance at being bothered can be deferred by explaining to him that he, for the moment, is next year's theater supervisor.

The final issue for background research

is the operator. The question is simple: "Who ran the audio for last year's productions?" If students weren't the operators, ask why. It's possible that the conglomeration of equipment they now have is so con-

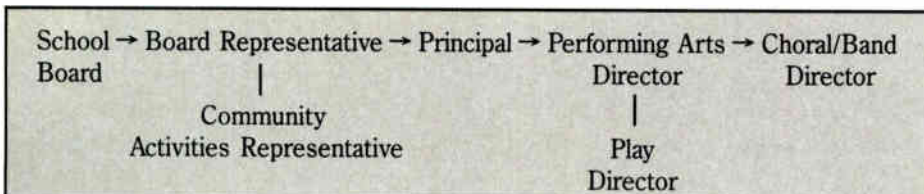
"One of the key differences from professional production venues is that, like churches, there often is no real plan for the types of productions to be held over the next five or ten years."

fusing or "touchy" that students aren't trusted. School officials should know that the system you are installing could be student operated, with supervision. (Make your best judgment as to who actually will operate the system and interview these people if possible.)

## SYSTEM DESIGN THE HOUSE SPEAKER SYSTEM

The house speaker system for the high school theater has seen a variety of design approaches, most commonly the center cluster, the left and right cluster, and a combination of the two. The combined approach, of course, requires more budget, design time and operator skill.

A cost-effective combined approach is to use a pattern-controlled center cluster with left and right playback speakers. This approach is not effective in an extremely reverberant room, however, where stereo



imaging is unachievable with this basic a system.

Regardless of which design approach is taken, the speakers should be moved as far forward as possible (rigging and esthetics can be limitations). To be positioned back next to the proscenium arch, a speaker cluster would need to be a high "Q" system with terrific pattern control, considerable operator experience and microphone setup. The cost of this type of system is often beyond the high school budget.

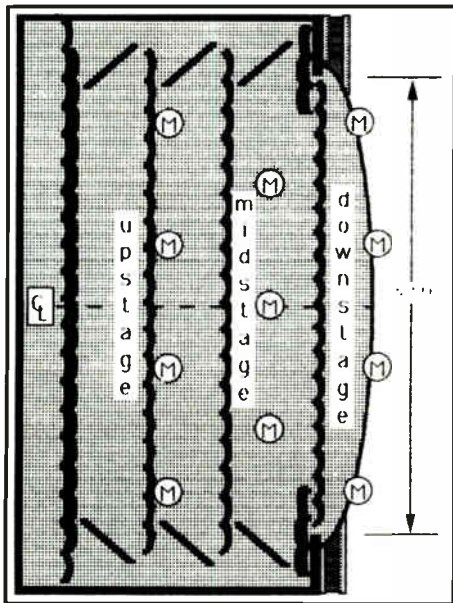


Figure 1 — Sample stage plot for area microphones.

An area of speaker system design that cannot be compromised is rigging. The client should know that this type of design and installation should be executed only by experienced rigging professionals. At this time there are no known certification programs for becoming a rigger; therefore, experience can only be gained by working as an apprentice.

### THE MONITOR SYSTEM

Stage monitor systems for high school theaters are delicate matters. What becomes important are the types of productions held and the attitude of the director toward the use of monitors. However, in the sound booth, a monitor is always

recommended.

The types of productions that can safely use a stage monitor are speeches, small band concerts, talent/variety shows and some types of choir concerts. Stage monitors are very difficult to work with in theater productions or any situation where area or omnidirectional lapel mics are used. If the director insists, a highly directive, carefully placed system is usually recommended.

There are several manufacturers offering inexpensive, powered compact monitors for use in the sound booth. It is suggested they be installed permanently, in a fixed position, facing away from the audience and toward the operator.

### THE AMPLIFIER SYSTEM

The features suggested for high school theater amplifier systems focus on providing user information, reliability, resistance to tampering and upgrade flexibility. The amplifier system would also accommodate the range of uses of the sound system. These uses range from speech to orchestral percussion.

Front panel metering should provide line level status, thermal status and protection system status. Reliability factors include low-maintenance design (variable or non-fan cooling) and overload and overheat protection. Tamper-resistant design calls for rear-mount volume controls. Upgrade flexibility can be accomplished with amplifiers that accommodate upgrade modules.

### THE PROCESSING SYSTEM

Processing for sound systems in this type of venue generally consists of equalization and crossover. With the advent of high performance passive speaker systems, crossovers are often unnecessary. Equalization can be provided for by one or more third octave EQs, although parametrics are still the favorite for some designers.

The important issues for a processing system in a high school sound system are tamper resistance, low noise floor and headroom before feedback (voicing the speaker system to sound as sweet as possible while riding the hairy edge of

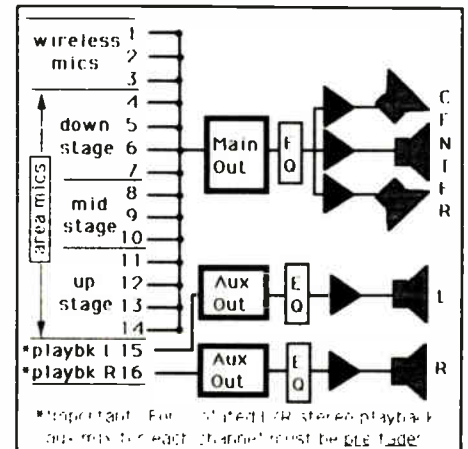


Figure 2 — Sample mix structure: center cluster and L/R playback.

feedback is not recommended).

Programmable processing equipment such as a digitally controlled equalizer can answer all of the above mentioned needs, at a affordable cost. An installer can insert a slave unit into the system, program it with a portable master unit and dump the stored settings into his computer system when he returns to the office. Programmable audio processing units today can store over one hundred settings at a time.

### THE MIXING CONSOLE

Simple is the best word for describing the optimum console for this type of venue. The basic desk should include enough mic channels to accommodate all stage area mics plus those in the wireless system. Metering should consist of easy-to-see and understand displays, monitoring main left and right, subs (if any) and monitor system output. The output stage of the console should meet the needs of the speaker configuration and the recording system.

Controls for each channel required by the novice operator are the basic three-band equalizer, headphone cue switch, L/R pan, sub assign (if applicable), aux and/or monitor volume(s), input gain and input pad. Other important features are headphone monitor and talkback mic. Performance features should include a low noise floor and minimum crosstalk. The proper console for this type of application is one that has these features and very few more — to avoid overwhelming the operator.

(continued on page 52)

# AN ALTERNATE PERSPECTIVE ON THEATER SYSTEMS

BY BILL HENDERSON

**B**efore one can truly assess the results of any endeavor, there must first exist a list of criteria that qualify the objective. This is certainly true when evaluating sound system performance, for the end result can be highly subjective. What pleases one may annoy another, and so the battle rages on.

When I think of an auditorium, I think “theater,” since most auditoriums are designed for a variety of performing arts. Hence, in this article on sound for auditoriums, I will routinely refer to a “theater system.” My primary concern here is to express my views clearly. I would never be so presumptuous as to believe my way is the *only* way. It is *a* way, and it has worked well for me over the years. Many good people have helped me over the years, but I would like to express my deepest appreciation to Mr. Rolly Brook with RB Systems, the first “major” consultant in this industry to give my ideas serious consideration.

When designing a theater system, the primary objective should be “realism” of the sound reproduced. To enjoy theater at its best, the sound should be so “real” that the patrons are not consciously aware a system is in use. The system should provide a natural extension of what is going on “live.”

The second objective is to strive for ergonomic, or *user friendly* design. All other objectives relating to features and performance should be subservient to an ergonomic design. The system should work *with* the technician, not against him.

*Bill Henderson is a designer for Spectrum Audio Video in Oklahoma City, a sound contracting and design firm specializing in systems for auditoriums, churches and the performing arts.*



*To avoid violating the esthetics of the Enid High School Auditorium in Enid, OK, 16 B.E.S.T. CT-62-D Transducers, were covered with blue grille cloth. Other transducers were placed behind the existing grille work.*

A well thought out system can be a joy to operate, while a poorly laid out system can be an operator’s worst nightmare.

These same criteria can easily be used for most church systems. With the growing interest in performing arts among many churches, and the special emphasis usually placed on musical reproduction, it is not unusual to see a church opt for a full-blown theater system.

With the above objectives as a goal, the next question becomes how to accomplish these goals, because a number of restrictions exist. First, and probably foremost, is budget. The system designer may have little to say in this area; the contractor even less. However, if budget is no problem, then the next consideration is usually architectural. If the project is new construction, was an acoustician brought in to help with design? If budget permits, it would certainly be recommended. (Sadly enough, this consideration is almost always ignored in new church construction.) If the system is going to be installed in an

existing structure, what are the room acoustics like? What considerations need to be given to building structure and mounting? What about visual esthetics? All of these play an important role in the fundamental design of a good system.

Many years ago, as I contemplated these questions, I was haunted by how inadequate our technology seemed to be. We could send a man to the moon, but it seemed to be impossible to find a performing arts center or church with a decent sound system. Oh, many groups had spent enormous sums of money, but something was still missing. Most people arrived at the concert hall with better sound in their car than you could find in the hall. In addition to poor sound quality, system control areas were often poorly laid out, leaving the operator flying by the seat of his pants. I became convinced that it did not have to be that way, so I set out to find a solution.

The first area I set out to address was speaker design. Most systems today use some form of central cluster, employing an



assortment of horns and woofers. While these devices possess a number of positive attributes, I was looking for something I felt had an increased sense of realism.

After giving the situation much thought, I decided to explore alternatives in speaker design. Purely by accident, I discovered the work of Dr. Jose Bertagni in 1976, and was introduced to his technology which used flat styrene diaphragms. Although I was not fully convinced that the devices would work, let alone sound good, a friend prodded me into giving them a listen. After hearing them, I had to admit that the devices did work, but I was still not convinced they would be much more than a novelty.

There were, however, some aspects of Dr. Bertagni's design that were attractive. The size and weight of the units would make them perfect for portable systems, but would they stand up under the rigors of portable use?

A number of questions had to be answered. Since these devices were essentially omnidirectional in a free air, what about feedback problems? What about wall reflection? What about intelligibility?

My first step took me to 1,500 seat auditorium where I used a pair of Dr. Bertagni's units for a sort of "music appreciation" class sponsored by an on-campus organization. I was truly amazed by what I heard. The sound was rich with substantial depth, yet at the same time bright and articulate. But this was recorded music what would they live? Willing to give anything a try, I talked a college ensemble I knew into allowing me to experiment during one of their rehearsals. It was after that rehearsal that I knew without a doubt that I was onto something. I didn't fully understand what was happening at the time, but the results led me to continue my investigation. Today, the most prominent result of this effort is what I call the "proscenium line array" for use in theaters and churches.

My first line array was installed in cooperation with Rolly Brook on a project we worked on a number of years ago. The hall had 1,800 seats including the balcony.



*Control Room at Frontier School, Red Rock, OK. System includes an AHB System 8 24-channel mixer.*

Since Rolly had not used a B.E.S. line array before, he opted for a hybrid design — one that employed a conventional center cluster of horns with woofer box, and two vertical line arrays using four transducers, one array on either side of the proscenium. The diaphragms were installed directly into the grid structure and covered with grille cloth. The back was left open.

When the installation was complete, Rolly ran a complete TEF™ analysis of the system. The sound quality and intelligibility were excellent, and time alignment was absolute. The dispersion of the line array was consistent with the flat plane of the B.E.S. transducers, or 180 degrees. The greatest achievement, however, was that the client loved it! More importantly, they still love it, six years after the fact!

In order to understand the performance of a line array, some fundamental ideas must be reconsidered. First, most speaker systems in large spaces are made up of an array of focused-field devices, with the central cluster design being predominant. The idea behind using focused-field devices is to create a point-source of sound, and to be able to control sound directivity to prevent spill onto walls, etc. This point-source of sound is generally intended to originate from a speaker cluster in proximity to the person speaking, usually above center stage. Hence, attention is drawn to the person speaking. This is a very valid concept, and has merit. Realistically, however, in some installa-

tions, it can appear that the sound is originating from a speaker system 30 or 40 feet above the person speaking. What was intended to promote realism could actually destroy it.

On the other hand, if a proscenium line array of flat diaphragms is used, then the point source no longer exists. This can be an advantage, when you consider the varied uses of an auditorium. A theater, church or auditorium rarely has activity concentrated in just one place. The actors or performers can be anywhere on stage during a scene. Using a point source can become a distraction, when the sound is not only above, but dozens of feet to either side of the activity.

By contrast, a line array will delocalize the sound; it seems to come from everywhere. With a little help from the world of psychoacoustics, a person can perceive the action and the sound in sync. I have witnessed people who heard a difference in sound, just because they physically saw more speakers in place, even though the speakers were not hooked up! The way the brain processes what we hear in relation to what we see is truly remarkable, and can be helpful in sound perception. What a line array does for music can be truly marvelous. If you are using live mics on a large vocal ensemble, for instance, about the only way you will know the system is on is to turn it off! The sound can be that real! It goes without saying that you must learn to operate this type of

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pensive output transformers. For long cable runs, Com-Tech can also be configured in a 140V bridge-mono mode, significantly reducing wire costs. With less wire loss from

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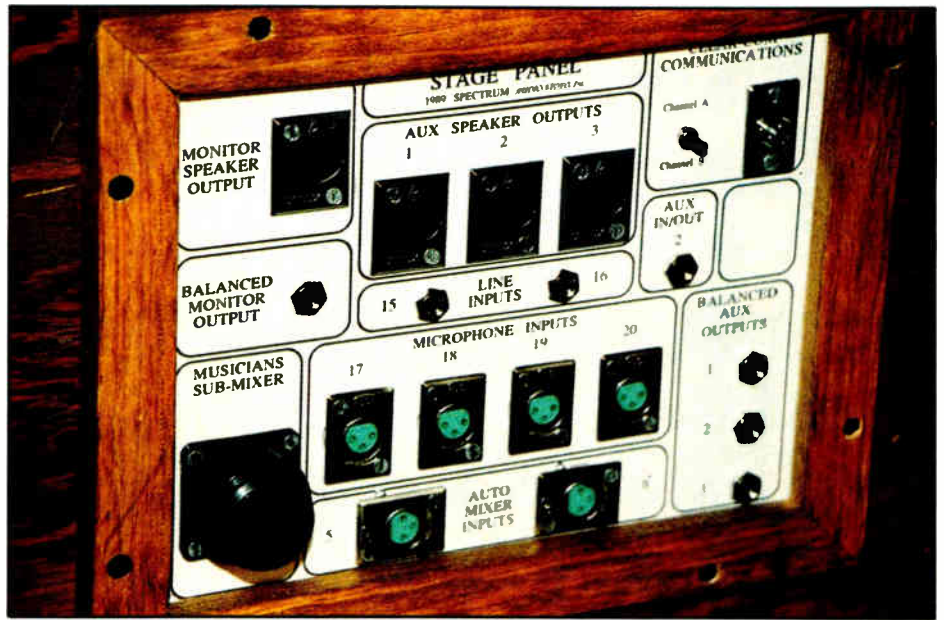
system in a different way. Once you are used to it, however, you may never want to operate anything else again!

One objection sometimes raised with this concept is that a line array system lacks "presence." If by "presence," you mean the sound is aggressive, and hitting you in the face, then you are right, a line array has no presence by that definition. I am also aware that some people want this type of sound. If, however, by "presence" you mean that the sound is all encompassing; detailed, yet with extraordinary realism — by that definition, a line array definitely has "presence." Many people find a focused-field system irritating, while others do not. Many, too, find a line array much closer to reality.

Overly-aggressive sound systems are more prominent in the world of rock and roll, where volume sometimes is everything. This approach is of little little relevance to theater and the performing arts. While a theater system should be able to achieve a comfortably loud level, sheer volume is not everything. As professionals, shouldn't we focus on quality and realism? Shouldn't it be our goal to install systems that sound as good as possible, within the confines of acoustics and budget? A theater system by nature demands our best efforts.

Line arrays really are not that difficult to do. Fact is, you may discover a new definition for ease of installation.

(The transducer technology from B.E.S.T. is more suited to use in line arrays than anything I know of. If you were to apply conventional cone technology as a line array, you would immediately encounter phasing problems and a narrowed beamwidth. Neither of these come into play with the B.E.S.T. transducers when used in a line array. Dispersion stays the same as with individual units, and phasing is not a problem. Wall reflections are excited less by the B.E.S.T. transducers when compared with focused-field devices. There are also architectural advantages. First, the transducers can be directly installed into a grid system with little effort. Because they are thin, and relatively light, you have more flexibility of



*A typical "stage panel" design used in Spectrum's theater systems.*

placement in walls, above prosceniums, etc. They operate full range, eliminating the need for an electronic crossover, while at the same time providing a certain amount of engineering redundancy in multi-amp systems.)

In my system designs, I split the line array into three parts — left, center and right. Because of the dispersion characteristics of the transducers, you can achieve stereo separation anywhere in the room. While stereo is not necessary for ordinary P.A. applications, when you get into the world of music, theater and sound effects, it can be very helpful, in addition to enhancing the sound of recorded music.

In a properly designed line array, you can achieve an S.P.L. of 110 dB steady state. Frequency response can go as low as 30 Hz, and in my systems I start a 3 dB per octave roll-off around 8 kHz. You can achieve higher frequency response, but using the B.E.S.T. transducers, it gets to be a bit harsh. There is still measurable high frequency information on out to 16 kHz and beyond. In some systems I have installed, gain-before-feedback exceeded 25 dB at stage center, and 18 dB at the outer edge, under the proscenium.

Installing a good speaker system is only the beginning of a good theater system. You must also consider function and ergonomics of design. What makes a theater system a theater system is its flexibility.

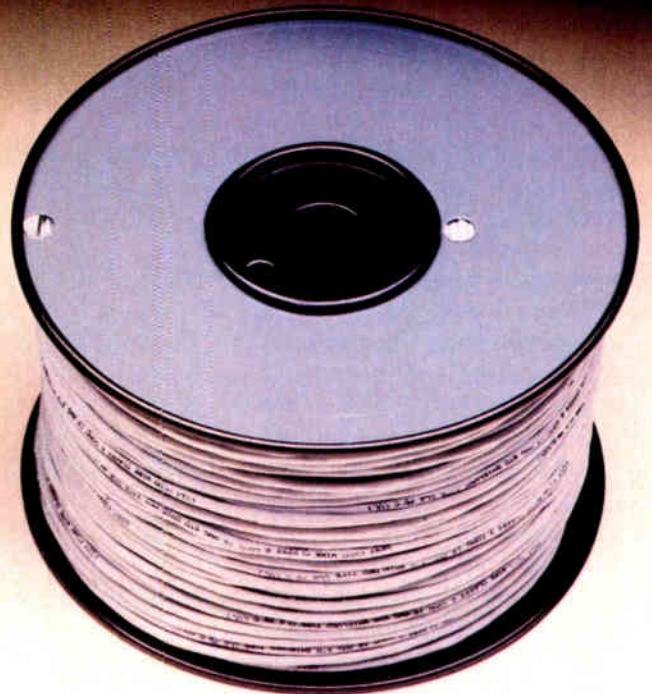
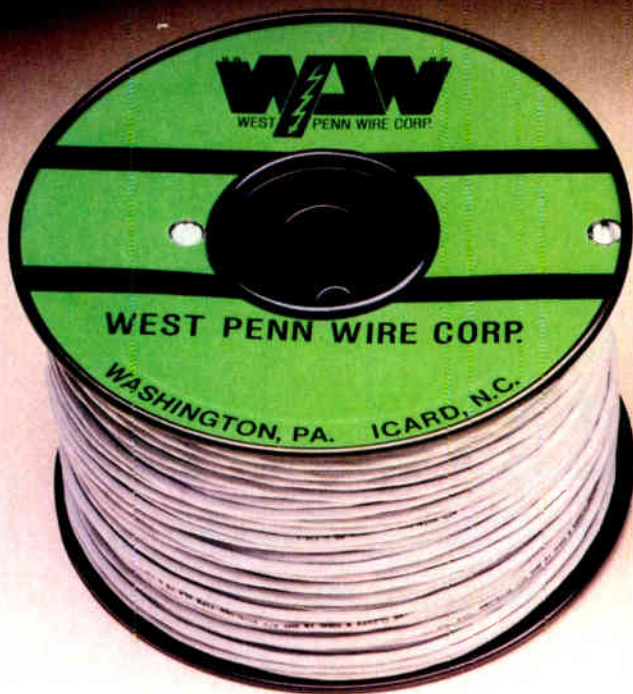
It is a sound system plus much, much more.

A good theater system should include a comprehensive communications system of the hardwired variety, such as Clear-Com, RTS, Telex, etc. I would recommend a wall-mount station for the sound control area, lighting control area and if space allows, a director's station. If space is limited, you can generally build a directors station in with the lighting console.

In addition to a good communications system, I would recommend a "stage page" system and a "back stage page" system. These systems can run off a simple 70-volt line. The "stage page" system would include a small speaker system on stage so the director can talk from the control room without yelling. (I've found a pair of BT-82s from B.E.S.T. works nicely when hung from chains attached to the structure or one of the flies in the loft.) Wall mounted units could also be used. The "back stage page" system would require a separate 70-volt line system, and would connect to speakers in the dressing rooms, scene shop, etc., and could be used for cues both during a rehearsal and during a performance. I usually mount a small gooseneck mic, such as the Astatic 827, into the sound and lighting consoles, or use the optional base which will give you a push-to-talk switch. The same mic can feed both the stage and backstage

*(continued on page 55)*

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## NAB 1990

By Allan Varela

**T**he 1990 National Association of Broadcasters (NAB) show in beautiful downtown Atlanta was an event and a half that brought out what's new in the audio and video field. Even though this show focuses on TV and radio broadcasting, production, and post production, some very familiar Sound & Communication names were also present showing off their wares. New systems; new technologies — these things are very critical. However, the most important thing of all is client awareness and sophistication. Client demand for better and more advanced systems is already having a great impact on the sound and communications business, and some of these new directions were present at NAB.

A new flock of R-DAT (Rotary head, digital audio tape) recorders and editors were seen nesting among the exhibits. The significance of this category of tape recorder is twofold: the digital recording format itself, and the advancements in tape technology. New evaporated metal particle tape technologies are impacting this recording medium, and eventually will allow up to five hours of recording on one cassette. This amount of storage time can be had using the same size cassette that is presently used to yield two hours. The clear and quiet digital recording a DAT machine offers is vastly superior to an analog cassette machine. This sonic superiority combined with the long storage time on one cassette will insure DAT being specified over the analog cassette.

Panasonic was slightly ahead of its time by introducing a new line of DAT machines. The SV-3900 features external computer or remote control of all transport functions. The SV-3700 features a front panel shuttle wheel for easy cueing. The SV-255 is Panasonic's new portable. The SV-3900 comes with a full function remote, the SH-MK 390.

Sony introduced a new line of three



machines as well; however, Sony's machines are able to track SMPTE/EBU time code. The PCM-7050, PCM-7030, and the PCM-7010 represent the full line and run from a very full featured deck to one that is more affordable. These machines are ideal for computer controlled installations. The RM-D7300 DAT edit controller was shown as well.

SMPTE/EBU time code is a digital code that represents hours, minutes, seconds, frames per second, and bits of each frame. This is a standard code used for film and video production and enables an operator or computer to know where different production events are stored. This allows editors to lock up audio tape machines with video tape machines, insuring that all of the different program materials present will be in sync with each other. Of importance to the sound and communications community is that inexpensive video systems are becoming laden with features, and many facilities will want to document their functions by combining the audio goodness of a DAT recording from a

separate audio system with the new, agile video recorders. No longer will a simple camcorder percolating in the background be sufficient for future production needs.

Microphone systems abounded, with many of the new entries in stereo. The clear advantage of a stereo mic system is the flexibility of polar patterns, the ability to narrow the pick-up field, and, of course, the sound. Combine one of these mics with a DAT recorder and suddenly the church choir comes alive. The school orchestra never sounded this good as the natural balance of the players is reproduced. The attempted mix of multiple mics by a novice technician with a less than good board, or worse, the very ambient mono sound of an omnidirectional mic dangling from the ceiling will disappear with the use of a stereo mic.

The M-S (Middle-Side) concept came from broadcasting where a mono signal (consisting of L plus R or sum), and a difference signal (L minus R) are transmitted. A mono set can pick up the full signal from the sum channel, and a stereo

set will recombine the sum and difference channels to rebuild the original stereo. The M-S mic system, basically put, consists of a single element facing front as the sum signal (M), and a bidirectional element oriented at 90 degrees as the difference signal (S). The M-S mic system usually employs a sum/difference matrixing transformer which allows the stereo field to be expanded and contracted.

Beyerdynamic introduced its MC 740 stereo condenser microphone for use as an M-S (Mid-Side), or X-Y stereo mic. This microphone is designed with two double diaphragm capsules arranged vertically on top of each other. The upper capsule can be rotated 360 degrees in relation to the lower element to dial up different patterns.

Shure and Sanken both released new stereo mic systems. Shure released its

VP88 stereo mic. This product is a classic M-S mic set up. The mic can be used as in X-Y or straight stereo mode or can be set up to deliver M-S capabilities. Sanken came with three models. The CMS-2 MS stereo mic is "the world's smallest and lightest" stereo mic. The CMS-7, and the CMS-9 are larger portable mic systems, with the CMS-9 having an internal matrixing system.

The AMS Soundfield system refines the stereo mic concept to a fine art by employing a multiple element mic. This mic in turn is fed into a special matrixing system that allows the engineer to literally dial up a pickup pattern that can reject the audience ambience behind the mic. In a less than ideal acoustical environment like a church, this mic system can be a god-send for feedback control.

The future of the business as a whole

is going to hinge on the bright new technologies and directions that were displayed at the NAB. The systems that used to cost tens of thousands of dollars are now being had for under ten thousand dollars. Production of video and audio on a professional level is accomplished the way it is done because it gets the job done. The giant technical leaps that have occurred in the past five years have allowed system costs to drop to the point where these production techniques can be had by the smaller user like a high school or church. Getting familiar with SMPTE and MIDI codes and the computer interfacing that is required has gone from "who cares" to "must know." A full understanding of these new directions will provide the sound and communications company with the ammunition needed when these new systems are installed. ■

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# AMPLIFIER TRENDS

## PART 1: COMPUTER-CONTROLLED AMPLIFIERS

BY PAMELA MICHAEL

*"Microprocessors are getting into everything. We won't be able to pick up a single piece of equipment in the near future, except maybe a broom, that hasn't got a microprocessor in it."* —Arthur C. Clarke, author of *2001: A Space Odyssey*.

Not since the 1960s when engineers and designers made the electronic leap from tubes to transistors has the amplifier market seen a change as dramatic and far-reaching as computer controlled audio equipment. What follows is a series of articles that look at this development and the several other overlapping trends which characterize the recent past and the future of the industry.

Sound contractors are not an adventurous bunch when it comes to trying new equipment and methods, often with good reason. The problems of reliability and performance with early transistor equipment, for example, certainly made the average sound contractor more conservative; if you're shipping something out the door with your name on it, you want to make sure it works, and will keep on working. Early transistor amplifiers did not live up to their developers' hopes or promises. Their overload characteristics were very poor, they didn't perform well at high temperatures, and people criticized "transistor sound" (which proved to be due mainly to crossover/notch distortion and excessive feedback).

Yet there were great incentives to make the switch from tube equipment from the point of view of those doing permanent installations: Tubes required replacement every year or so, and ran hot, and output transformers lost a lot of low-end bass response.



*Crest Audio's CC301 is an example of a power amplifier with modular construction.*

In the beginning, transistor technology caused more problems than it solved, partly because people initially tried to design transistor circuits like tubes, and partly because of problems inherent in the early semiconductors. The move from unstable germanium to silicon was an improvement, but initially this was expensive and fraught with supply problems. Silicon transistors and better solid state design techniques, however, prevailed. Computer-controlled amplifiers undoubtedly will, too, because the benefits are too great to ignore and because the more technologically sophisticated customer will demand increasingly "smart" systems. New techniques will be forged of necessity, and gradually objections and resistance will be overcome. Experience will improve design and application.

At present, though, many contractors are still operating with technology that is ancient (but familiar) compared to other segments of the industry. The conservative approach of the sound contractor,

however, while limiting in some regards, is no doubt a big factor in the general stability of the contracting market, which has consistently displayed a steady, gradual growth rate.

In discussing the fast-paced changes in technology with designers, manufacturers, contractors and end users for this article, several trends were almost universally acknowledged: According to the forecasters, the direction of power amplifier development has moved toward:

- Computer Control
- Reduced Size and Weight
- Higher Output
- Multi-Channel Consolidated (more than two channels in one box) Signal Processing/Amplifier Mainframes
- Digital Design

This month we will take a close look at the trend toward computer control.

Computer (and digital) technology is being increasingly employed in amplifier design. Many amplifiers contain microprocessors or accept modules containing





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*The Crown Com-Tech 1500 power amplifier.*

computer circuitry which offer a dazzling array of computer controlled functions: remote monitoring of equipment, fault monitoring and indication, remote gain control, diagnostics, polarity change, signal processing, EQ, level adjustment, cooling system control and drive, and many others.

A related development is the interfacing of amplifiers and personal computers. Computer-based systems can control two or three amplifiers in the studio, 100 amps on tour, or 500 in a large stadium. As in every other industry that is being altered by the computer revolution, the IBM/Macintosh dilemma persists. At the moment, IBM compatibles seem to have the edge in the pro sound arena, with many end users and contractors preferring its less expensive hardware. IED and Crown, which pioneered software for the industry (controlling multiple amps and giving feedback on such things as signal levels and clipping, and AC and DC power supply integrity) originally designed their software packages to run on Macintosh, but now offer both options. BrystonVermont, a new player on the software scene, is offering only IBM compatible software, betting on continued preference for IBM in the market. Since not only amplifiers, but many equalizers and other signal processors, are being introduced that operate under computer control (MIDI or serial port), it will become more important for the host computer to accommodate multi-tasking. This is the capability of the computer's operating system to run different programs simultaneously. On the Mac, this function is implemented with the Multi-finder, while on IBM compatibles you might use Presentation Manager, OS/2, DOS 4.0, or Double-Dos, among others. In any case, multi-tasking requires a few meg of memory.

Alternatively, we can hope that standards will be developed so various functions (from amplifier gain to equalizer settings) can be controlled from a single program. Certainly MIDI is an established interface standard for musical instruments, although perhaps it is not ideal for pro sound. IED has suggested that a RS-422P standard be worked out so that any power amp that has this interface can be connected with their controllers.

*Sound & Communications* sponsored a meeting of sound system software developers at the NSCA Expo in April to discuss setting standards for file interchange of room models and speaker directional files; and the group has agreed that ongoing meetings will be held. One extension of this group could be the development of standards for file interchange between sound system design predictive software (such as the PHD program, AcoustaCADD, CADP, etc.) where the amplifier's gain settings for uniform or intended sound levels would be transferred to the sound system computer controller (such as those available from IED, Crown, or Bryston). While this will not eliminate painstaking proof-of-performance, the starting point of the amplifier gain settings

would be at the levels used in the sound system design simulation software. We will keep you posted on these developments.

For large scale permanent installations, like hotels, airports, or coliseum-sized touring situations, as well as the complex dynamic events of your average theme park, some degree of computer control is becoming almost essential. Additionally, the fault monitoring features of many computer controlled systems are proving to be an effective selling tool for the contractor. The benefits offer compelling, cost-effective incentives, and options to the end user.



*The JBL/Urei ES Series of Power Amplifiers includes models ES150, ES300, ES600, ES900, and ES1200.*

A brief description of the first crop of computer-controlled amplifiers follows, including a couple recently introduced at NSCA and one not even being shipped yet at the time of this writing. In subsequent issues we'll take a look at the other identified trends in the power amplifier field.

IED (Innovative Electronic Designs, Inc.) was the first manufacturer to offer multi-channel capability in one case under computer control. Early systems were



*The QSC MX 4000 Dual Monaural Amplifier.*

## AMP TRENDS



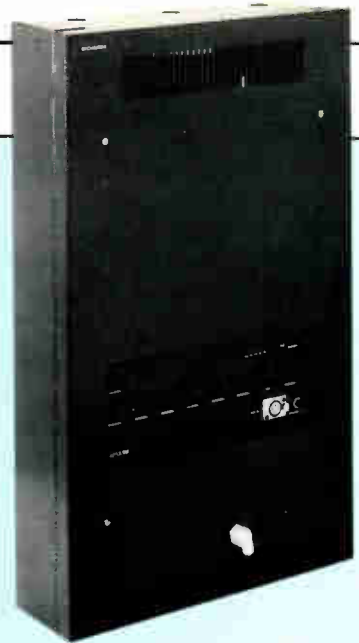
Hacoustic amplifiers AMP 2075 and AMP 2120, feature 9 inputs with 6 mixables.



The BGW 8500T Power Amplifier.



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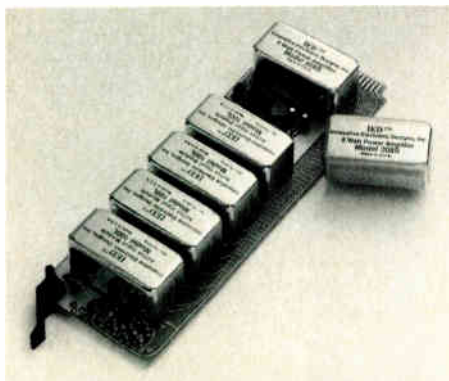


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## AMP TRENDS

controlled by a Sony computer which also had popularity in the interactive video disk market.

Later systems have mostly used the Mac computer. Airports, stadiums, and theme park installations were quick to adopt computer control. The advantages of automated, programmable functions for this type of application soon became obvious to acoustical consultants, sound contractors and facility designers. The ability to program certain announcements or events that go on every day — the lunch bell, “the park is closing,” etc. — as well as complex dynamic events, such as a



The IED 6208 Power Amplifier card for the Class D 6000.

parade through an amusement park where it is necessary to move the music along with the action, made such systems desirable.

They are also desirable if, perhaps, you have an event in the park and you don't want to draw everyone in the park to that one site, just those close by, or you want to broadcast from one location to the rest of the park, or from one location to another.

IED's Class D 6000 Series is a modular card system offering 6208 or 6270 Power Amplifier cards and Model 8084 mainframes which hold either four or eight amplifier cards. The 8208 has 200 watts per channel into 8 ohms and the 8270 has 200 watts into 25 ohms. Both are balanced, floating, isolated output designs. The 5000 Series line of audio circuits allow a variety of configurations for mixing, processing and distribution.

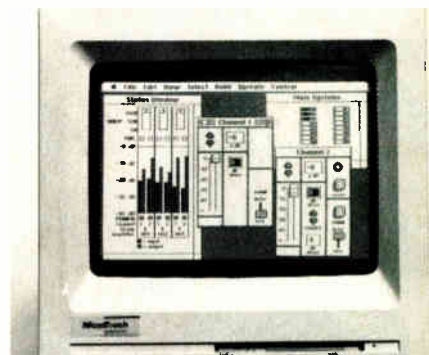
IED has suggested standardizing an RS-422P serial data format so its controllers and software will be compatible with amplifiers (such as those from Urei, Bryston, Crown and others) that provide this interface.

Crown's IQ System 2000 uses a personal computer (initially only Macintosh; but an IBM version was introduced at the recent NSCA Expo) for computer-driven amplifier control and monitoring. Both versions have the capability to control up to 2,000 amplifiers in a single system. The IQ 2000 system is compatible with Crown's Macro-Tech and Com-Tech amplifiers. The Mac software is graphics oriented, while the IBM compatible software is spreadsheet based. The monitoring and control functions are essentially the same between the two formats. Either format can be operated in real time by an operator, or pre-programmed, such as for airports and large industrial environments. Four screens are used in the IBM software. The set-up or control screen appears following a roll call of the amplifiers on line. Amplifiers in the system can be given addresses and logged according to their type, location, and purpose. Control functions are found in the middle of this screen, while monitoring capabilities are located to the right.

The second and third screens provide bar graph and visual displays of individual amplifier functions such as energy reserves and input/output comparisons.

The fourth screen is for control and is used for various functions such as a master level control, zone control, troubleshooting and so on.

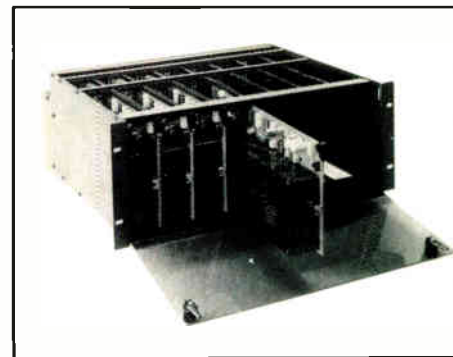
Aside from a Mac or IBM compatible computer, the IQ 2000 system includes an IQ-PIP Card and an IQ System Interface. A fully functional computer system in its own right, the IQ-PIP is a circuit board which fits into the rear of each (Macro or Com-Tech) amplifier used in the system. The IQ-PIP's function is to send or receive information from the host computer via the IQ System Interface (which is also outfitted with its microprocessor, serial ports — RS-232, RS-423/RS-422 — and power supply).



The control screen as shown on a Macintosh SE.

Based on commands received from the host computer's keypad, the IQ System Interface selects individual IQ-PIP cards in the system, requests data from those specific cards, and then returns it to the host computer. Runs of up to 1,000 feet can be made with #26 twisted pair wire. Up to eight different serial loops can be connected to the IQ System Interface, and each of these loops is capable of being coupled to 250 amplifiers, for a total of up to 2,000 amplifiers per system.

The selection of power amplifiers is certainly not limited to their remote control



The IED 6084 Mainframe holds up to eight 200W amps.

capabilities, but also construction, sound quality, cost, reliability and numerous other factors. If you are specifying a system that requires remote control of inputs and levels, yet the amplifiers you prefer to use do not have remote control capability, then Oxmoor may have a solution through the use of their mixing matrix and digital control attenuator. The new RMX 44 (4 in, 4 out) and the RMX 62 (6 in, 2 out) are distribution amplifiers that can mix and route inputs and output



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## GTE-60 AND GTE-100 AMPLIFIERS



### DESCRIPTION

The GTE line solid state integrated 8 channel amplifiers will control, mix and amplify 6 microphones and two auxiliary inputs. They are capable of delivering full RMS power continuously to speaker voice coils and 25 or 70 volt lines.

### FEATURES

- ★ 6 microphone channels with built-in balanced low impedance microphone transformers.
- ★ 12 volt phantom power for microphones.
- ★ Telephone page input switchable thru mic 6.
- ★ 2 auxiliary inputs for tuner, tape, music.
- ★ Music channel has loudness contour switch.
- ★ External switch mutes music.
- ★ 10 band equalizer.
- ★ Speech filter for each microphone.
- ★ Automatic volume limiter.
- ★ LED photo conductor for remote microphone control.
- ★ Mix input BUS.
- ★ High fidelity circuit with reliable overload and short circuit protection.
- ★ Heavy duty power supply.
- ★ Designed for constant duty operation.
- ★ Professional female 3 pin latch lock microphone connectors.
- ★ Barrier strip speaker terminal plus 2 speaker jacks.
- ★ 25 and 70 volt output line can be balanced or unbalanced.
- ★ Output for tape recorder or booster amplifier.
- ★ Illuminated power off-on switch.
- ★ AC convenience outlet with ground.
- ★ 3 wire AC cord for safety grounding.
- ★ Circuit Breaker and fuse protection.
- ★ Illuminated VU meter.

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through a 25 pin Control Port. All that is required to route any input to a chosen output is a switch closure. Control ports can be paralleled up to 64 units. For remote level control, Oxmoor's DCA-2 Digital Control Attenuator interfaces (up to 2000 feet) through modular phone cables by digital pulses with their RC-16. Each DCA-2 has two channels which can be controlled separately or can be ganged together. Default levels can be preset, and priority adjustment levels can temporarily change through external control. Computer control of levels of the Oxmoor equipment is possible through third party software (with communications modem programs such as Procomm, Xtalk, and Red Ryder in conjunction with relays), but this feature is not directly supported by Oxmoor yet.

Bryston is entering the computer control field in a big way with their BX Series of amplifiers, which will be shipped in August. BX-Control is a site oriented program which allows the user to define several individual site specific setups (hockey, tennis or dog show, for example) and store them on a disk. Up to 256 channels of amplification can be controlled from an IBM compatible personal computer. Initial amplifier choices are 100 watt and 200 watt per channel (dual-channel) units based on Bryston's 3B



*Bogen's DPA-160 Power Amplifier.*

and 4B power amps. BX versions add a microprocessor subsystem that handles communications with the computer and monitoring of amplifier status (primary power, DC supply, output level/clipping, and input level). Any pre-defined setup can be easily loaded, even by untrained personnel, by simply selecting the setup name from a list displayed on the computer screen. Punch "hockey" and the system turns on amplifiers programmed in the "hockey" configuration to pre-set gains. Discretionary level adjustment is limited to about plus or minus 6 dB, with anything past that, the unskilled user cannot influence — only those with system passwords will have access to make modifications.

The IBM compatible computer requires EGA color graphics, mouse and two serial ports (one a common RS-232 for the mouse, the other a RS-422 for amplifier control). Up to 4,000 feet of cable can be used between the computer and the amplifiers. The BX-Control software is menu driven for ease of operation. While the program allows for directly controlling or monitoring any specific channel, its primary use will be to define acoustic zones and then to control the system by sending commands to zones and groups of zones.

*(continued on page 70)*

# THE IMPORTANCE IN DOING BUSINESS

BY CHRISTINE BUNISH

**T**he hotel industry today has come to realize the important role a quality sound system plays in doing business. "Sound systems used to be treated as a line between carpeting, wall coverings and potted plants," says Phil Cartier, project engineer for Baker Audio, the Atlanta audio contractor. "Now many hotels realize they must have good quality sound systems to remain competitive, and they understand if they make the investment it will make them money."

Steven Hood, project consultant at Costa Mesa, California's Paul Alan Magil & Associates, a consulting firm for A/V, security and TV systems, attributes hotels' "marked demand for improved audio" to "the home environment and digital technology that's raised peoples' consciousness about audio. People are now aware of what once was perceived only by an audio experts' educated ears."

Although hotel sound systems can encompass background music in public areas and restaurants, along with music and spoken communications in ballrooms and other function rooms, this article deals chiefly with sound systems in multi-purpose ballrooms and function rooms.

While Joe Davidson, manager of the sound division at Long Communications, an electrical systems contractor in Winston-Salem, North Carolina, believes "everyone wants improved sound quality," he points out that "many are still surprised at what it costs. They think it's a great idea until they see what it costs to accomplish. The smaller, private hotel properties sometimes wind up buying a bare-bones system through a music contractor who offers a mic input."

Some hotels "put in whatever's cheap, and maintenance problems ensue," agrees Fred Schafer, head of F.C. Schafer Con-



*Atrium Restaurant in Redondo Beach, CA after finishing (B.E.S.T.).*

sulting of Concord, North Carolina. "They want something that doesn't cost a lot and that makes money, but they should understand that downtime is not acceptable."

Steve Schlaff of Brooklyn, New York's Norcon Communications Inc., which fabricates, supplies and supervises low-voltage communications systems, recalls seeing telephone cable used to run mic lines and home-quality combining systems rife with dangling wires. Long Communications' Davidson has witnessed marginal-quality sound systems affected by cheap wall dimmers that cause quite an audible hum.

Baker Audio's Cartier cites an instance of an international hotel chain known for its premium service and prices which took the lowball route on a sound system for a new property. "Their thinking was five to ten years behind the times," he says. "Speaker coverage was poor and they used poor quality equipment. Within a year we were asked to go in, rip it out and put in another system. Everything had to be upgraded.

"In the overall scheme of things, going first class doesn't cost that much more than going second class," Cartier adds. "It may be a matter of \$100,000 versus

\$60,000 and it's a false economy not to make the investment."

Retrofits of existing sound systems are usually regarded as more difficult and more expensive than starting from scratch. "In general, renovations are much more troublesome than new construction," says Larry King, a principal in Klepper Marshall King Associates Ltd. (KMK), acoustical consultants based in White Plains, New York. "You spend extra time in design and construction of the existing space; with new construction you have more leeway on where to run conduit."

KMK and Norcon were instrumental in the retrofit of New York City's Grand Hyatt ballroom, which was a redo of the hotel's second sound system. "The original system was a bit underpowered and the first redo was a relatively inexpensive attempt to correct this, but not make

major improvements," KMK's King explains.

"Customers continued to have bad experiences with the speakers and voiced their displeasure to the management who decided to try again," he adds. The third-version system called for installing more powerful speakers in the existing black boxes; no new plastering or ceiling work was necessary.

Bruce Bohl, West Coast regional sales manager for B.E.S.T., Santa Ana, California, notes that "many contractors put the emphasis on very good electronics — a fine mic mixer or music system — but when they look at distributing sound into the room, they'll sometimes go with a discount loudspeaker assembly or underestimate coverage characteristics."

Selecting a less than experienced or reputable contractor to build and install a

hotel sound system, and sometimes even spec the audio equipment, is also a false economy, though the lure of a contractor's low bid may be strong. Paul Alan Magil's Hood recounts a case in which a hotel took on a low-bid sound contractor whose firm later went under and resurfaced in the candy-bar manufacturing business.

Hood also recalls a low-bid, small contractor who had negotiated with a hotel for his lodging and wound up with a self-perpetuating vacation: "The hotel griped about the system he installed 11 months of the year, then the contractor showed up for two to three weeks every winter to 'work on the systems' although he was most often to be found by the pool," says Hood.

Long Communications' Davidson reminds us that "sound doesn't work alone," although Baker Audio's Cartier

## THE SOUND COMBINATION DESIGN & QUALITY

The ML-112 and ML-132 Ballroom Combining Systems — The first control systems on the market *specifically* designed to properly mix and combine the audio components in a multi-room situation.

Both the ML-112 and ML-132 Systems are currently installed around the world in hotels, conference centers, restaurants, industrial planning centers, and auditoriums. Imagine systems so simple to operate that the catering staff can set up the sound system in seconds.

A graphic map of your ballrooms is designed for every system, complete with mix switches, head table locations, LED indicators, and visual feedback.

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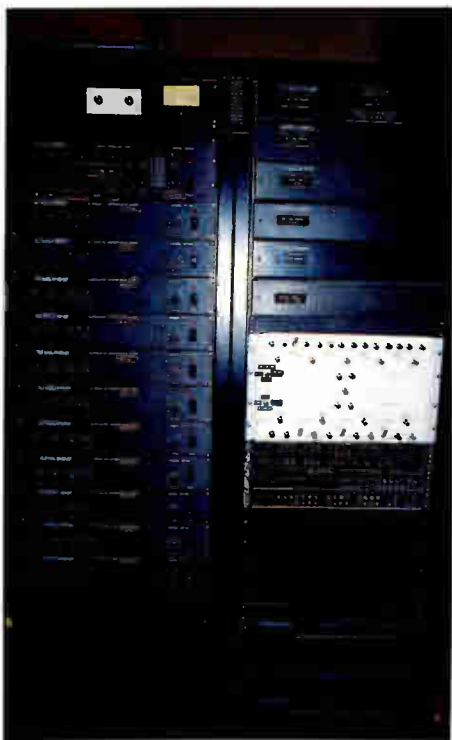
Call for your free copy of our ML-132/ML-112A design booklet featuring an article by Jeff Loether, Marriott Corp.

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## HOTEL SOUND

sometimes finds "sound and acoustics questions are not addressed at the architectural stage. A lack of knowledge can cause significant problems: meeting rooms wind up next to kitchens with insufficient insulation between them, noisy HVAC systems destroy rooms, and partition walls extend only half-way up. More nice rooms have been ruined by a lack of noise control or a lack of understanding of acoustics."

Cartier lauds Atlanta's Westin Lennox Hotel as an example of a project where "the sound system was on an equal footing with the architecture. Everyone worked together to achieve good sound. It took commitment from the top but that commitment filtered down through the architect, interior designer and all the trades."



One of 10 independent sound systems in the New York Marriott Marquis.

Jeff Loether, manager of audio/video systems design for the Architecture and Construction Division of Marriott Hotels International, Washington, D.C., stresses the importance of "the location of the sound equipment with respect to the spaces served." He describes what was required simply to adjust the mic volume

in a particular hotel ballroom: an employee had to traverse the ballroom and service corridor, take an elevator up two flights, cross the kitchen and public corridor, pass the night club and front desk and walk down a flight of stairs to the sound equipment rack. "It's so critical to have sound and A/V equipment storage convenient to the spaces served," he emphasizes.

Hotel sound-system design must ultimately focus on the system's end user: Will it be operated by an in-house A/V or banquet staff? By an on-site third-party A/V company? Or by whomever books the ballroom?

Bill Larkin, senior regional manager of KVL Audio Visual Services, Inc., Elmsford, New York, a firm under contract to provide a number of hotels in several different states with an on-site A/V department, wishes his company was more involved with the consultants and contractors.

"They're not averse to talking to us, but red tape prevents us getting together," states Larkin, who explains that senior-level staff who could act as liaisons are usually not hired until the hotel has been designed and built. "When we enter the picture the budget has been cut, money spent and the hotel is eager to get the cash flow going. The operators have to make do with what's handed to them."

Paul Alan Magil's Hood notes that "one of the smoothest running situations is one in which the contracting firm also runs the hotel's A/V department. Since they use the facilities, they have a distinct interest in the equipment working correctly. It's a good way to do business," says Hood.

In many cases, a lowest common denominator approach to the end user is followed. "You have to design a system for anyone to operate," says Baker Audio's Cartier. "There may be operators with varying degrees of competence or an assistant junior catering trainee who gets thrown into a situation on a Sunday night. You need a truly bulletproof, foolproof, one-button system."

Paul Alan Magil's Hood concurs on the importance of a user-friendly system. "You don't know if there's going to be a high-caliber person available in the middle

of the night when things need to happen," he emphasizes.

Fortunately, today's technology enables hotels to get what Hood calls "the best of both worlds: equipment flexible enough to handle the most sophisticated events, yet friendly enough for any user. To the outside observer, a system may appear simple, but there are microprocessor controls behind the scenes."

West Paterson, New Jersey's FSR Inc. developed its ballroom audio combining systems to fill the need for what president Bill Fitzsimmons refers to as "a Class A sound system that you don't need a degree to run. Hotels were spending money to buy very good components but after installation the systems were trailing off in performance, and that hurt the meeting business.

"It used to be a case of a contractor customizing each combining system but there was a need for a system that was friendly enough for the catering staff to run and easy enough to install so a contractor wouldn't get called back all the time for why-didn't-it-work diagnostics," Fitzsimmons continues.

FSR's microprocessor-based ML-132, ML-112 and 112A ballroom combining systems each feature individual room control-panel wall plates as well as a customized master "map" control panel depicting the ballroom floor plan. One press of a button instantly makes the independent audio of selected rooms become one without physically patching amps and mic mixers.

Hotel catering staffs, and even guests, use a key switch on the wall plates to go from music to microphone functions and to control volume. FSR's combining systems are found in a number of Marriotts, Red Lion Inns, Sheraton and Hilton hotels and the brand new Pinehurst Hotel & Country Club in Pinehurst, North Carolina.

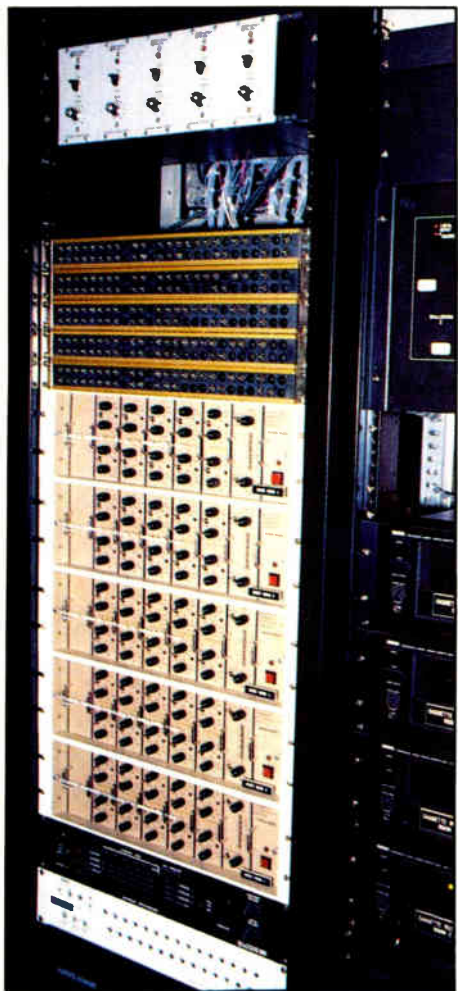
Innovative Electronic Designs (IED) introduced its Hotel Audio Management System three years ago and has recently seen its installation at the Hilton Lake Buena Vista, Florida, the Trump Castle in Atlantic City and the Queen Elizabeth Hotel in Montreal. This computer con-

PHOTO COURTESY OF NORCON ELECTRONICS, INC.



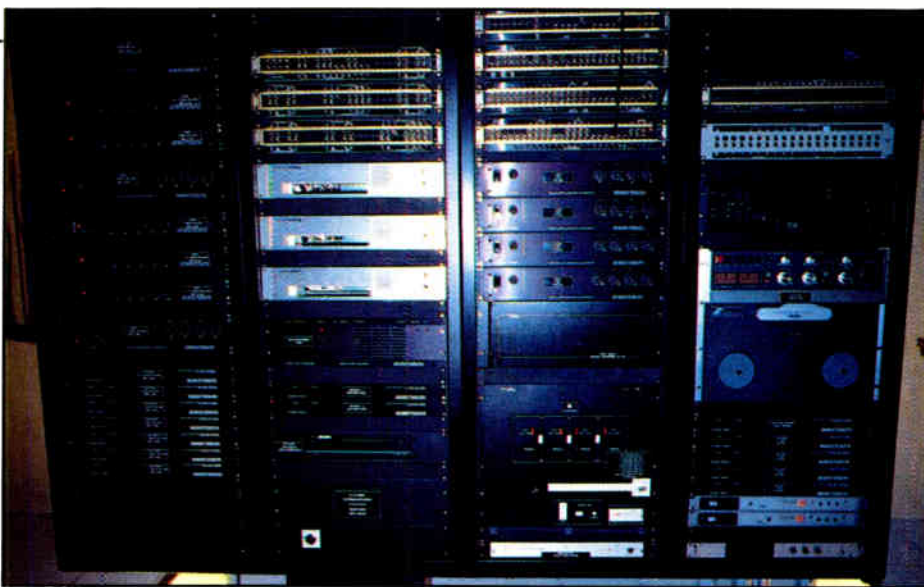
trolled system enables hotel personnel to enter the parameters of future events at their convenience and when the event time arrives, the computer automatically performs the set up: it combines and separates rooms, assigns head-table locations and controls background music. No operator need be present.

"We had been doing computerized systems for convention centers, so we just scaled down the technology a bit for the hotel market," explains Tom Roseberry, vice president of IED's marketing and sales. While IED also produces micro-processor-based controls for manually-operated switch-panel systems and Roseberry believes "both levels of systems need to be represented for some time into the future," he notes that "cer-



Part of Main Ballroom sound system at the Grand Hyatt Hotel, New York City.

PHOTO COURTESY OF NORCON ELECTRONICS, INC.



Crowne Plaza Hotel's main system contains equipment by FSR and Altec.

tain leader-type hotels are interested in using computers."

The Hotel Audio Management system boasts simple, on-screen menus that can be mastered by a non-technical person in a few hours. "We keep improving the software and functions," says Roseberry. "We now have a generic piece of software with a lot of applications. We're also able to go back and update our older systems as we find a better way to do things."

B.E.S.T.'s Bohl notes that often, "We find rooms under excellent control by the combining systems, but when the rooms open up, the loudspeakers fight each other."

When setting up a hotel sound system, Fred Schafer encourages clients "to aim for even-quality products throughout. It's better to have a great Chevy than a Mercedes with a bad engine," he quips.

Marriott's Loether draws a similar parallel in rating the reliability of a system tops. "I'd rather have a reliable, low-tech system than a high-tech system that's quirky and occasionally fails," he states.

Loether notes that "video equipment has traditionally not been permanently installed in hotel sound systems multi-purpose meeting spaces since it can be easily rented."

KVL Audio's Larkin cites ballroom plug-ins for video cameras whose signals can be redistributed to other meeting rooms featuring monitors and large-screen projection systems. "This is extremely helpful in a large convention overflow situation; it's a big selling point," he says.

B.E.S.T.'s Bohl reminds us that no matter how sophisticated the delivery method,

whatever video distribution or satellite transmission, "what's created in the loudspeaker and the way the loudspeaker delivers sound in the room" is the key to an effective end product. "What you hear is what you get," he emphasizes.

Unless a hotel changes its sound requirements, "There's no reason why a properly-maintained system shouldn't last 10-20 years," says Fred Schafer. However, he believes it's important to ask hotel clients involved in new construction what they'd like to be able to do with their sound systems one day. "If the client has an idea of what they'd like to do, we can put in conduit for it now so we don't have to tear everything up later," Schafer points out.

Frank Curry, chief sound engineer at New York City's Waldorf, has taken that hotel through six generations of sound systems in his 25 years at the landmark hostelry. "The original 1931 design has carried us through to today with periodic updates as the state-of-the-art has progressed," he explains.

From using Western Electric racks in 1965 to wiring for video distribution and installing Altec's Micro 4 Audio Grammar, a third octave equalizer with realtime analyzer he jokingly calls "HAL," Curry sees the future of hotel sound merging with technologies like fiber-optic networks and satellite links.

"You can't get by with one narrow train of thought," he states. "You have to be able to turn a room around in 30 seconds. You have to think about all the possible scenarios. If you don't stay up with what's new, you're lost; the industry will roll over you." ■

(continued from page 33)

## MICROPHONES

Two types of microphones are recommended for high school theater audio pickup: dynamic low-profile cardioid, for area pick-up; and a wireless lavalier microphone system, recommended to be non-diversity for budget and simplicity reasons. The lavalier element should be omnidirectional for flexible body placement.

The area mics have three stage positions: approximately nine feet overhead, hung downward, with positions covering mid-stage to upstage; across the front of the stage, placed either on the stage edge (floor mounted with vibration isolation) or on stands across the floor below the stage, with the microphone one inch above the lip of the stage; and one stage position where the microphone is hidden in the set. This last placement is used in desk drawers, plants and other props near a location where a good portion of the action is to take place. A final note to make for the area mic is that if bands or choirs are to be miked with the same unit, the hand-held low-profile should be selected over the floor-mount since it is a more versatile unit.

Affordable wireless systems are available from many vendors, so let's focus on the specific requirements of high school theater. The receivers should be simple, durable, and offer front-panel signal strength metering and rear-panel volume control. The transmitters should be able to withstand many impacts with the stage floor, have an audio-off switch and a battery strength indicator. The lavalier microphone should not be overly sensitive to sudden transients. These diversity wireless systems as a whole should have a minimum one hundred-foot range and operate in the VHF bandwidth.

## THE CABLING SYSTEM

Cabling design for the high school theater sound system does have some important elements. Overall attention should be paid to extensive labeling and documentation, as curiosity is epidemic in the high school environment. Durability is an issue, therefore microphone cabling should be as rugged as tour cabling. Regardless of the type of cable required, pay strict attention to NEC codes. It is not unreasonable to put the burden on the school for providing

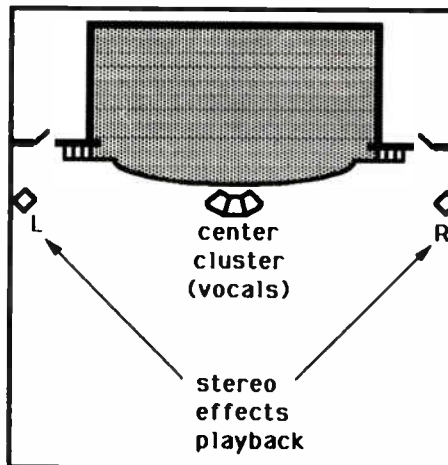


Figure 3 — Sample speaker layout for center cluster and L/R playback.

sign-off for your NEC compliancy. This is not to say you shouldn't do your own verifying.

Multipair cable and labor costs for the run between stage and console can be controlled by using a manufacturer-supplied audio snake featuring a "fan-out at the console" and a "stage box" at the stage. When specifying the number of channels, leave room for two intercom runs and two spares. Plenum NEC codes can be met with either a plenum-rated snake or by running in a two-inch or better conduit.

The cable run between racks and console should be simplified with a manufacturer-supplied umbilical multipair cable, terminated at both ends with appropriate connectors. Simply specify length, cable type, connectors and labeling. This approach minimizes confusion when cables get rearranged mysteriously after the install is complete. Further problems can be avoided by building a wooden cover over the back of the console.

## REMOTE CONTROL

Many high schools will request a remote control system for the sound and lighting systems. If the client doesn't make the request, it should be suggested. Remote control allows all or part of the system to be used during simple events or rehearsals, without an operator. Security may also be an important reason for the school, as high school theater sound booths often become unattended during lengthy shows or rehearsals requiring no gain changes.

The locations for the remote panel(s) is

up to the school in most cases. However, try suggesting a backstage location with a lock-box, away from lighting dimmers. The panel should have, as a minimum, an on/off switch (with sequential turn-on) and a master volume control, both with LED indicators. Budget is the limiting factor concerning how complex you get. Obviously many options exist, since several manufacturers offer a wide range of remote control systems at reasonable costs.

## ADDITIONAL SYSTEM OPTIONS OR UPGRADES

Three common options that may not be part of the original design are a recording/playback system, intercom and a hearing impaired system (although states are beginning to require H.I. systems in public venues over certain capacities).

The recording/playback options are normally cassette and/or reel-to-reel. Budget normally restricts intercom to hardwired systems, which should consist of a minimum of three locations: backstage wing (director), audio mix location and the lighting console location. Hearing impaired systems are normally of the infrared type, although hardwired systems have also been successful. H.I. systems is an area that should be studied intensely, since this will soon be a required aspect of audio installations.

## INSTALLATION BY PHASE

Many high school budgets require that a complete sound system be installed in phases. This is a concept practiced regularly in the theatrical lighting industry, where a dimmer system alone costs as much or more than an entire sound system. Assisting the client in facilitating for a phased installation requires that the design be broken into phases.

Phase one may entail integrating the new speaker cluster/amplification system with their existing front-end system. The decision to integrate or not is a judgment call made on a case-by-case basis, involving such factors as the client's potential uses for the room. Once the decision has been made, a budget-tailored multiple-phase plan can be laid out for the client, with a working system from the first phase forward.

- Increased “liveliness” in the room.
- Missing or greatly reduced levels at certain frequencies.
- Image shifting.

The key physical areas of concern are those areas where a listener is likely to be present within the coverage overlap of the combination of devices.

### SYNCHRONIZATION PARAMETERS

In order to successfully bring the combination of devices into useful physical alignment and electronic synchronization, or both, it is necessary to identify:

- The acoustic origin.
- The acoustic center.
- The wavefront propagation point.
- The expected coverage angles.

See Figures 3 through 5. (Figures 3 through 8 are presented here by courtesy of Don Keele of Techron who created them

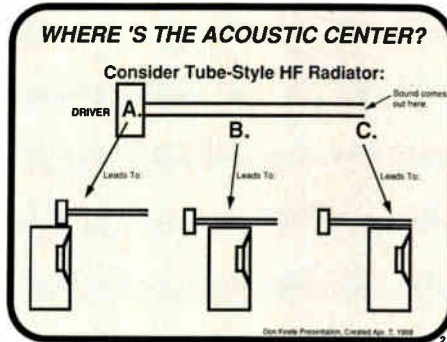


Figure 3.

for presentation at the Syn-Aud-Con Loudspeaker Designers' Workshop in April 1988.)

The day will surely come when advanced manufacturers will publish each of these parameters as part of their specifications. This is not a trivial task as these parameters will vary from the same driver on differing horns and at various

crossover frequencies.

From the above data it can be determined if the devices can be reconciled (some simply cannot), and how to do so if correction is possible. When the acoustic centers can be reconciled by physical placement, then the acoustic origins can be synchronized via precision electronic signal delay devices. The emis-

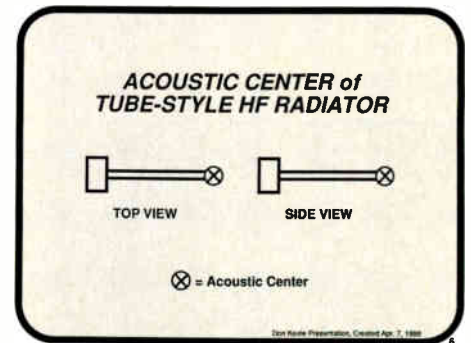


Figure 4.

# Menlo Scientific

## Acoustical Consulting and design services for sound contractors

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sion points of the wavefronts must, at a minimum, not provide reflecting surfaces to each other.

As can be seen from Figures 6 through 8, the multicellular horn was ideal for adjustments of this type since their acoustic centers remain at location in both principal planes and are usually within the desired high frequency tolerance distance to the acoustic origin. This means that you can align their mouths physically and synchronize their origins and centers electronically.

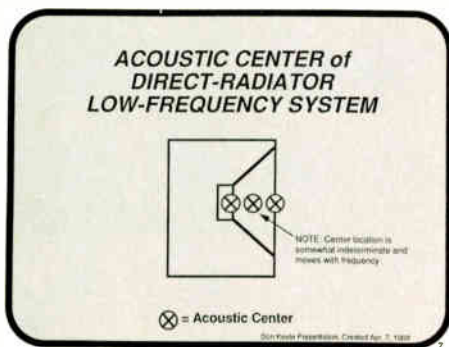


Figure 5.

**TIME AS DISTANCE — DISTANCE AS TIME**

The basic equation is that:

distance (d) = time (t) multiplied by velocity (c)  $d = tc$

For sound in air we can generalize a velocity at 72° F of 1130 ft/sec or 344 m/sec. If we make  $t = 0.000001$  sec, i.e., one microsecond then:

$d(\text{in feet}) = (0.000001)(1130) = 0.00113 \text{ ft.}$

If we multiply by 12 in order to obtain inches, we get  $0.00113 \times 12 = 0.01356 \text{ in.}$

If instead, we would like to know how many microseconds there are in one inch, we would write:

$t = d/c = 1/12/1130 = .008333/1130 = 0.000074 \text{ s or } 74 \text{ microseconds}$

Further, if we found that sound had travelled one foot in 885 microseconds, then

$c = d/t = 1/0.000885 = 1130 \text{ ft/sec}$

This simple equation from the most basic of physics concepts is a continuously useful tool in all kinds of calculations, be it audio or travel.

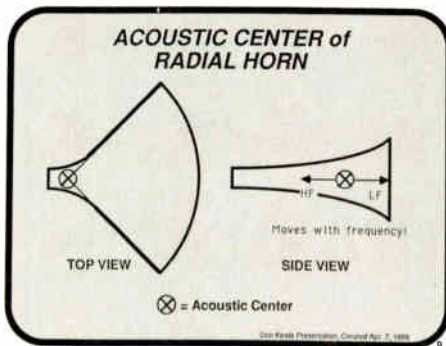


Figure 6.

An alternative way to look at this is to say, if sound travels 1130 feet in one second

$1130 \text{ feet/1 sec}$

then, how many feet will it travel in  $0.000001 \text{ sec}$  (i.e., one microsecond)

$1130 \text{ feet/1 sec} = ?$

$\text{feet}/0.000001 \text{ sec}$  and multiply by 12 =  $0.00113 \text{ feet} = 0.01356 \text{ inches}$

**THE NULL FREQUENCY INTERVAL (NFI)**

If, in examining a 1/3-octave realtime analyzer plot, you find that you have a deep notch at 1500 Hz, most likely it's the first notch in a comb filter series of notches. What distance missynchronization would you look for?

Since the null frequency interval NFI is directly proportional to velocity  $c$  and inversely proportional to distance  $d$  then,

$NFI = c/d$

therefore,  $d = c/NFI$

If we made  $c$  in inches per second  $1130 \text{ feet/sec} \times 12 \text{ in.} = 13,560 \text{ inch/sec}$  we would find for our question above that:

$d = 13560/1500 = 9 \text{ in.}$

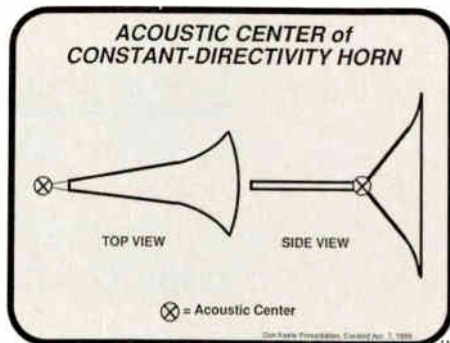


Figure 7.

**TWO FORMS OF SYNCHRONIZATION**

There are two existing basic signal synchronization techniques. The first one is the one where both drivers are covering the same frequency range and share some common overlap area of their coverage. It is highly audible when improperly done. The second one is where it is necessary to make sure that the output of a high frequency unit arrives in synchronization with the output of a low frequency unit through the crossover region. These fundamental parameters must be resolved in any successful system. These two cases are illustrated in Figure 9.

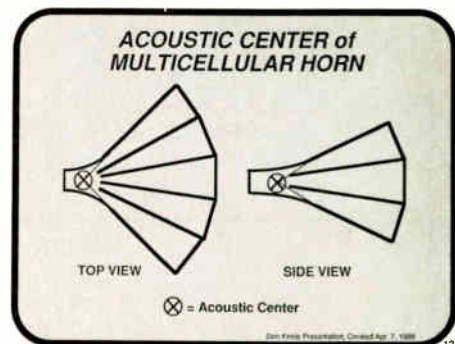


Figure 8.

**HOW TO PROCEED WITH ALIKE DEVICES**

The first step is to work in the overlap area between two of the devices. You will first adjust two followed by turning them off when you adjust another two. Then twos can be combined with twos, etc. This procedure of working in pairs can be carried on until even the largest arrays are brought into the optimum adjustment possible for the devices at hand.

Using "pink" noise and a 1/3-octave real time analyzer (preferably with 0.5 dB amplitude resolution or better) make the coverage as even as possible in the overlap zone with the wavefront propagation points of the two devices in physical alignment. Once you are satisfied that the physical alignment is as precise as you can achieve (i.e., the mouths of the horns are as close together as you can get them and still cover the areas they are assigned to) then

(continued on page 70)

# THE SINGLE BOX SOLUTION:

## BGW SPA-3 Signal Processing Amplifier

About two years ago, BGW decided to take a long look at the then-current state of the art in amplifying systems. And when we did, we saw room for improvement. The typical installation included several channels of amplification, of course, along with quite an accumulation of add-in and add-on boxes: An electronic crossover or two, a couple of time alignment delays, plus assorted EQ's, filters and more.

What's wrong with that? Well, all those separate boxes wired together require lots of rack space, cause inevitable installation hassles, and create an ongoing potential for reliability problems. Not to mention the cost of all those boxes.

That's why we created

ever need for virtually any application. It's a *complete amplifying system* in a single 5¼" rack cabinet—completely self-contained, completely flexible and completely reliable.

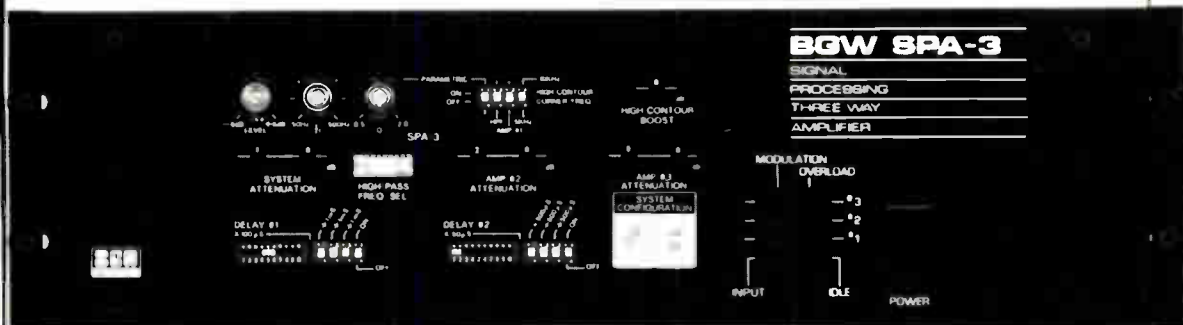
At the heart of the SPA-3 are not-two-but three 200 Watt (@ 8 ohms) channels of BGW-quality power amplification. Among the signal processing elements included are Low Frequency Parametric EQ and a High Frequency Contour Filter, a Switch-set™ High Pass Filter, a 3-way Electronic Crossover Network, two adjustable high-quality Delays for time alignment, even a full complement of Buffer Amps and Digitized Level Attenuators.

In minutes, the SPA-3's multi-pin "jumper header" plugs-in to let you set up the unit for dozens of different

wouldn't build it any other way!

The superior design, reliability and performance of the BGW SPA-3 has already proven itself in major installations from the Orange County (CA) Performing Arts Center to the OMNIMAX theatre in Australia. By the way, there's also a two channel Model SPA-1 with signal processing capabilities tailored to make it an ideal subwoofer amplifier. It's a time, space, aggravation and money saver too.

The logic of the SPA approach speaks for itself. But there's lots more to know about all the incredible capabilities of the BGW Signal Processing Amplifiers. For a full info pack, call us Toll-Free at 1-800-468-AMPS, (in CA 213-973-8090), or see your BGW dealer.



the BGW SPA-3 Signal Processing Amplifier—the single box solution that restates the state of the art. It's much more than just an amplifier, because the SPA-3 includes all the signal processing elements you'll

configurations, in the shop or in the field. The design is so flexible, you can even change the location of the attenuators, delays, etc. within the signal flow. And every processing function offers superb quality. BGW



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**ENGINEERED  
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## News from around the industry

### Voice Alarm for London Blitz; Russians Visit Michigan

#### War Museum Gets Fire System

A new voice fire system has been supplied to Britain's Imperial War Museum by Tannoy-Audix. The 12 zone system uses the Tannoy-Audix Vector Voice Fire Control System and covers all public areas, staff offices and the Museum Cinema. It provides building evacuation announcements from Eprom stored information, which also supplies other visitor announcements, background music, etc. An additional stand-alone system, specially designed for a permanent display which recreates wartime Britain under siege from air raids, provides blitz sound effects, slides to create fires and gun flashes, and a continuous voiceover commentary. A future extension of the museum will also be equipped with a Vector drive system.



Britain's Imperial War Museum

#### Rep of the Year

Loppnow and Associates, based in Issaquah, Washington, has been awarded "Representative Firm of the Year" by University Sound. In addition, Excellence Marketing of Eden Prairie, Minnesota, has been named "Most Improved Territory." Robert Sandell, president of University, said the awards "reflected outstanding overall sales performance" by the two organizations.



Left to right: C.W. Warburton, E-V director of international development; Steve Hollar, export manager; Yuri Dmitrievsky; Vitaly Enenko; Robert Pabst, E-V president.

#### Recent Installations

Electro-Voice has announced several recent installations using E-V equipment. Installations include the Kingdome in Seattle with Proshow USA acting as contractor; Club Quick in New York (contractor Perry Branston, with equipment purchased from AST Sound); Forest Fair Mall in Cincinnati (contractor Panacom Corporation); Lenin Circus in Moscow (contractor IFC of Wien, Austria); Hard Rock Cafe in Singapore (contractor Electronics & Engineering Pte. of Singapore). Electro-Voice has been discussing possible future business with representatives of a Russian audio cooperative.

#### Pulnix Distributor

Richardson Electronics, Ltd., Security Systems Division, has been appointed Master Stocking Distributor for Pulnix, Inc. Sal Raia, vice president and general manager of Richardson, made the announcement. Pulnix features a black and white and color video camera product line for the security, robotics and imaging industry. The Pulnix product line will be managed by Tom Brown, central regional sales manager for the Richardson Division. Raia said, "We will maintain a broad Pulnix offering adding to our better than \$3,500,000 inventory of CCTV products."

#### Ceramic Armor

Maxell held a press conference during the NAB convention to detail the effects of its Ceramic Armor Metal Particle tape technology on tape performance. The particles, 20 angstroms thick, cause the coating to have a number of advantages according to the company, including uniform acicular particles, a coating which inhibits oxidation and resists corrosion. The Ceramic Armor tape is available in Betacam, high definition and DAT formats.



Jim Ringwood (left) and George McBride of Maxell Corporation unveil Maxell's Ceramic Armor Metal Particle technology.

#### Applied Sound and Communications

AEI Music Network Inc. is now represented by Applied Sound and Communications of Floral Park, New York and Danbury, Connecticut. Applied Sound and Communications will represent AEI's tape and DBS satellite delivered products and music services.

Products

Soundcraftsmen Intros Pre-Ceiver; New Remote Control from Audio Access

Preamp/Tuner for Background Music

Soundcraftsmen has introduced its Pro-PT5R Pre-ceiver. Designed for background music installations, the unit is a combination Control Center/Preamplifier/Tuner which allows the cost saving of the combined preamp and tuner stages in a single chassis.

The features of the Pro-PT5R include Digital CMOS Switching, FET preamp, source selections including CD/DAT, Phono, Tuner, Audio/Video, plus two tape monitors with dubbing. A Spectral Gradient circuit is said to be able to eliminate high frequency harshness. Two pairs of line outputs are pro-

vided for Surround Sound applications or subwoofer/satellite speaker systems. A Variable Contour Loudness Control allows for selection of frequency balance at a given volume level. The digital PLL tuner section features a Microcomputer memory system, and automatic scanning to allow for programming of 16 stations.

Circle 1 on Reader Response Card



Multi-Room Remote Controller

Audio Access has announced its Multi-Room Remote Controller, the PX-6; a preamp designed to access audio and video equipment. The preamp accepts commands from either a wall mounted keypad or an infrared transmitter, and provides remote control of source equipment and volume level from everywhere in the facility.

The PX-6 provides control for up to five different input sources and can be integrated with other "Home Automation" type products. Volume level is controlled using a 256 step digitally controlled attenuator. An infrared

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flasher output allows IR signals to pass through the PX-6 for control of other equipment.

Circle 2 on Reader Response Card



**Transducers, Amps and Wall Speakers**

JBL Professional has introduced three new lines. The 2100 Series is a line of Large-Format Coaxial Transducers that consists of three models, the 2142H, 2152H, and 2155H. The 2142H features a 12-inch, low-frequency section combined with a 1.75-inch titanium dome high-frequency section. The rear housing of the 2142H includes biamp terminals and a network cover for modification or servicing. The 2152H and 2155H are, respectively, 12-inch and 15-inch low frequency sections combined with titanium dome compression drivers fitted to Flat-Front Bi-Radial horns developed for these transducers.

The ES Series of power amplifiers includes the ES150, ES300, ES 900 and ES1200. The end products of a computer-aided design facility the ES Series features reduced weight and compact size. Output ranges from 75 watts/channel for the ES 150 to 600 watts/channel for the ES1200.

The 8300 Series consists of two flush mount wall speaker systems, the 8305 and the 8306. Applications for the 8300 Series include custom home installations, small conference areas, hotel rooms, restaurants, lounges and lobbies.

Circle 3 on Reader Response Card



**Wireless Intercom System**

RTS Systems of Burbank, CA, has introduced the Series 2100 Wireless Intercom System as a cost-effective professional system that features full-duplex operation with up to four portable stations per base station. For larger systems, two base stations can be linked for an eight station network. The system operates in the high-band VHF frequency range between 150 to 216 MHz and offers a selection of 10 different frequencies.

The Model 2105 Base Station Repeater supports the portable stations and interconnects with hardwired intercom systems and is directly compatible with a number of intercom systems. The Model 2110 Belt Pack Transceiver is completely self-contained: batteries transmitter and receiver are all housed in a small, lightweight package.

Circle 4 on Reader Response Card



**Literature**

**University Sound Catalog; Jeron Brochure**

**Commercial Products Catalog**

University Sound, Inc. is publishing a new edition of its Commercial Products Catalog.

The 50-page catalog focuses on University's products in the commercial sound industry including microphones; horns, drivers and paging projectors; speakers; special purpose transducers; audio electronics; and utility and interconnect electronics and accessories.

Circle 5 on Reader Response Card



**Healthcare Catalog**

Crest Electronics has announced its full-line catalog of parts, accessories and medical equipment. This 180-page catalog includes thousands of replacement parts and components for hospitals, nursing homes and medical clinics.

Circle 6 on Reader Response Card

**Brochure for Nurse Call**

Jeron Electronic Systems has released a color brochure for its newest microprocessor-based Nurse Call. System AV-680 includes multiplexed operation which is said to reduce wiring by using three pairs of wires which loop from room to room, allowing for less conduit and wiring.

Circle 7 on Reader Response Card





# COMPUTER-AIDED-DESIGN AND TEST SYSTEMS UPDATE

BY MIKE KLASCO

**F**or some new product releases, delays, vaporware and general gossip concerning computer aided design, this month we present an update.

## SOFTWARE

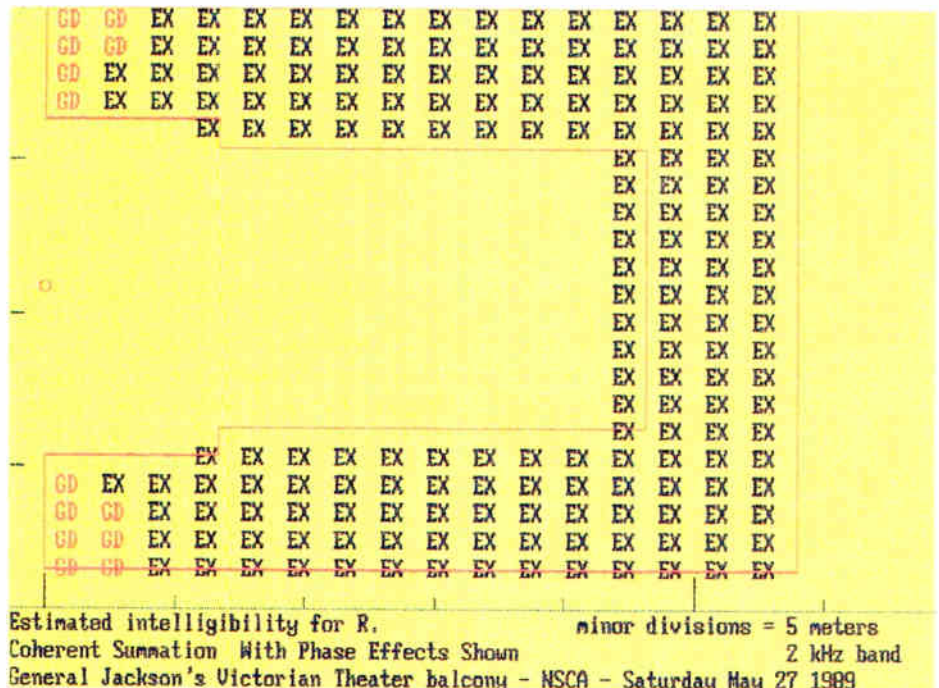
Renkus-Heinz has been distributing the ALS array interaction software for one year now and is contemplating expanding its software offerings with a full scale sound system design program developed in Eastern Europe. Release is anticipated for the fall and beta site volunteers are needed.

Although PHD 4.0 was released toward the end of last year, the printed manual has yet to be shipped. The manual will catch up with the program before the next release, we hope.

AcoustaCADD 1.1 has recently been shipped, which fixes some minor bugs in the initial launch version and also now includes University speaker files. John Lanphere of Altec mentioned that more efficient room modeling techniques for complex rooms have been developed and will be added to the software soon. RASTI and STI intelligibility prediction from ray tracing is also being included in the next release.

Bose Modeler 3.1 is expected to be previewed in the near future. I would guess the long awaited intelligibility prediction module will probably be included. Modeler 2.0 was reviewed back in January 1988 and I promised to come back to the program when the intelligibility module was included. Since that review, many other significant additions have been made to Modeler, both in ease of use and in performance simulations. (We are planning to begin reviewing Modeler this summer.)

Whatever happened to the French program NexoCAAD? At the New York AES



*An enhanced release of JBL's CADP is now available to licensed users from an independent developer. Among numerous improvements is higher resolution (up to VGA) and more color (up to 16).*

I met with Eric Vincenot, Nexo's president. He explained that Nexo had pulled back the program to integrate various program enhancements, such as an "isobeam-like" aiming aid similar to AcoustaCADD. Problems had to be resolved, such as the royalty to the (French) government sponsored agency that had created the program. It was too high to sell the program to sound contractors. Another problem was that the program database only included Nexo speakers, and finally, Nexo did not have an agent to market or support the program in the U.S. Until this situation resolves itself, I think we will have to wait for a NexoCAAD review.

The Case independent development effort has gone through personnel changes and other stumbling blocks. Eventually this

project may emerge (now estimated at the end of the year), and probably with a different name. For all the changes, the project is still very active.

Last year I reported on (and received a beta copy of) JBL's CADP 4.5, an upgraded version of CADP I, 2.0. I was impressed with the change from CGA graphics to VGA graphics, the use of color to show intelligibility boundaries, the enhanced quality of the cluster drawing module, and numerous other improvements. The prototype copy I had was buggy and crashed often. Furthermore, JBL decided not to distribute the program. but was allowing existing licensed users to buy (\$139) the upgrade directly from Bruce Olsen (612-493-4491), the independent

*(continued on page 65)*

# MLSSA TEST SYSTEM ANALYSIS, Part II

BY MIKE KLASCO

**O**ur further exploration of the MLSSA test equipment is an eclectic discussion of selecting a portable computer host so the system can be used for field use; information on your choices for your computer's coprocessor (required for MLSSA's operation); use and interface of the MLSSA system for speaker design and measurement; and finally, an overview of the significant enhancements to the software with release 6.0.

## *Selecting a Portable Host for Computer-Based Instrumentation*

Room measurements, cluster time alignment and interference effects tweaking. Noise surveys, and many other jobs require that the test equipment be brought to the test site. Although the MLSSA system will plug into any XT or AT compatible buss (the connectors on the motherboard), I think most potential portable computer buyers will find that their choices are limited for the MLSSA system.

In selecting a portable computer, the vast majority of laptops are not usable because a full length XT expansion slot is required. Typically, laptops either do not have expansion slots or can only accommodate small plug-in boards such as modems. Many portables offer an optional "docking" expansion chassis, but these are for desktop use and awkward for field use. Often, you may find yourself at a job site where AC power is not accessible, or connecting to AC power can be very inconvenient, such as checking for uniformity of coverage in seating areas, so battery operation is a real plus. Unfortunately, the most readable displays, such as the gas plasma display, are usually not available with battery operation.

A hard disk is not required for the



*Valnet's VGA Color Portable II.*

MLSSA system's operation, but at least a high density floppy drive is needed. Hard disk operation has some convenience and speed advantages, but cost, reliability, and battery life are compromised. If you can shut off the hard disk, then battery life will be extended during field use.

A coprocessor must be accommodated (a socket on your computer's motherboard is required). While all desk-top IBM compatibles offer an optional coprocessor, a number of laptops (and most "palmtops") omit this capability. (Coprocessors are discussed in detail in the next section.)

MLSSA offers compatibility with color (low-resolution) CGA, higher resolution color EGA, and the high resolution gray scale and color VGA standards. MLSSA does not support the medium resolution "double CGA standard" provided by many of the laptops, although it will work with these displays in the standard low resolution CGA mode. As the 600 x 400 standard is rapidly losing ground in portables

to the gray scale VGA standard this is a short term limitation, although expect to pay a \$500+ premium on your laptop for the privilege of a VGA LCD display and even more for a VGA gas-plasma display. At the moment NEC has the only laptop with a color VGA display (although Sharp is not far behind), but at \$8,000+ street price for washed out color, I would pass this by.

Perhaps the most elegant choice is the Toshiba 5200 laptop, which offers high resolution, full size XT expansion slot, light weight, hard disk, battery operation, and everything else you need for the MLSSA system. This is a nice computer, but you will pay for it (about \$7,000+ without the MLSSA).

If you think your computer is going to get rough treatment, then you might want to consider a ruggedized portable. A number of "manufacturers" have taken the basic portable cases that are clones styled after the Compaq III and have rebuilt them

## SOFTWARE REVIEW

into industrialized instruments, with a few models including shock mounted components. These computers are slightly bigger than a laptop but quite portable and easily taken on a plane. Although not intended to sit on your lap, they will happily fit under the seat with space left over for your feet. A few suppliers that I know of for this type of product are Valnet (414-344-7755), Dolch (408-435-1881), and ConSyst (215-398-0752). Options include LCD, cold cathode and gas plasma displays, 286 or 386 motherboards, and cost ranges from \$5,000 to \$15,000. At least three full size expansion slots are available (Valnet has five), although if the motherboard does not include the display adaptor, serial and parallel ports or the disk controller, these will get used up quickly. If you are on a tight budget, you may want to be adventurous and buy one

## CAD TOPICS

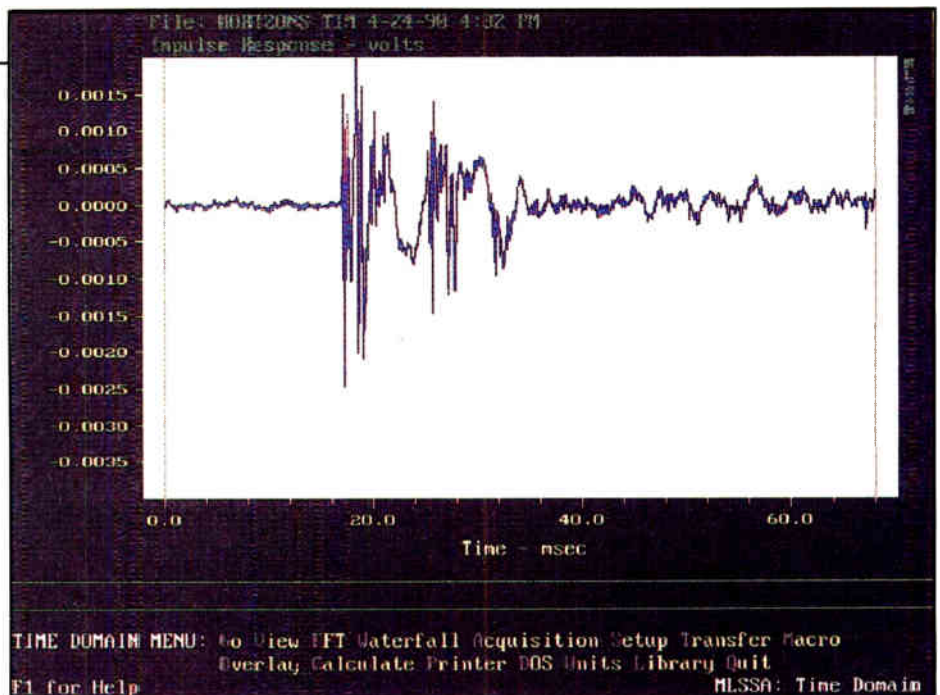
(continued from page 63)

developer of the program enhancements. The product has finally been debugged and is now being shipped. A review of CADP 4.5 and Xlate II is scheduled for future issues of *Sound & Communications*.

Another developer is offering the Xlate II, a file interchange utility for CADP I users that allows export to AutoCAD of CADP I files. Once exported to AutoCAD, many manual or semi-automatic operations can be done to your drawings, as well as output to plotters. Grant Elliott (64-9-434551), the program developer, is located in New Zealand, but some discussions are now going on to offer this program from a U.S. source.

JBL will be providing more info on their next generation program. Unofficially, late summer or fall has been a hoped for target release date.

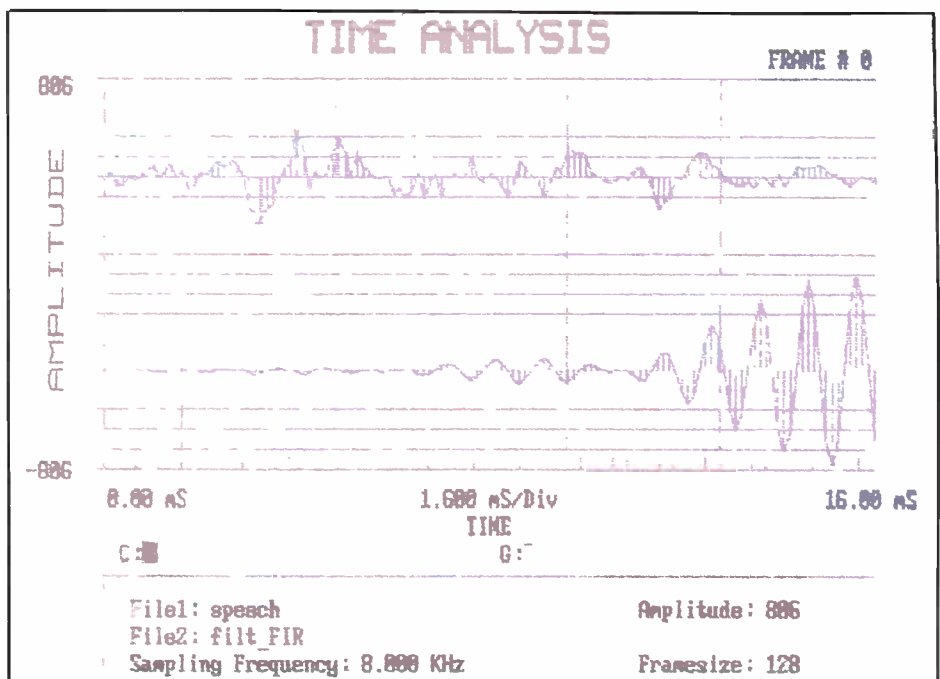
R.J. Lemker and Associates (606-261-9529) has introduced a program for predicting reverberation time for rooms. The program also functions as a design aid in determining solutions for problem rooms. We will be looking over this program and will include it in the



Impulse Response — volts.

of these units without the ruggedizing, but take it "straight off the boat" from Taiwan. A copy of Computer Shopper magazine will show dozens of importers selling versions of Compaq III clones, generally bas-

ed on tooling from two or three case factories, with an endless choice of motherboards, and various screen display options. Buying mail order is questionable, as you ought to see what you are going to get in



Hyperception's *Hypersignal Workstation* software runs on Ariel's DSP-16 board, as well as Ariel's *SYS-ID* software. Above is a dual channel time/amplifier plot.

series of capsule reviews of reverb/intelligibility/acoustical software-hardware this fall.

Techron has just announced the Techron

20, a single-rack-space add-on test system that interfaces with either an IBM/compatible or Mac computer. The Techron 20

(continued on page 67)

## SOFTWARE REVIEW

terms of display quality, keyboard feel, fit and finish and so on. Cost of these portables can be about \$1,200 for XT an version to \$4,500 or more with 386sx and VGA plasma display. Good luck.

If you are handy with tools, one of Toshiba's 3100 computers with a belly pan might be the solution for you. A Toshiba 3100 is less powerful than the 5200, but also about half the price. A third party supplier, Connect Computer (612-944-0181), offers an expansion chassis called the "One Under" that does not get in the way of the 3100's portability. It fits under the 3100 and looks like it is part of the Toshiba's case. The "One Under" expansion chassis can be modified (by you) to accommodate XLR connectors and the mic preamp, which would be ideal. The only fly in the ointment is the medium resolution of the cheaper Toshiba.

### WHICH COPROCESSOR?

The MLSSA system requires a math coprocessor to be installed in your computer. The math coprocessor is an integrated circuit that speeds your computer's number-crunching speed. Other computer-based test systems, such as Ariel's Sys-ID, and engineering software such as AcoustaCADD, AutoCAD and many other programs also require a math coprocessor. Hundreds of other programs will automatically detect the presence of the copro-

cessor and function 2x to 10x faster.

Until recently Intel was the only manufacturer of this integrated circuit chip. While Intel licensed the design of the 286 microchip to other integrated circuit manufacturers (the 286 is the brain of AT compatible computers), Intel kept the profitable coprocessor business all to themselves. To Intel's dismay, two other firms have recently introduced co-processors that simply plug into the socket on your computer's motherboard intended for the Intel part.

You simply cannot buy just any coprocessor for your computer. If you have an XT then you need an 8087, an AT requires an 80287, and a 386 machine takes an 80387. The clock speed that the coprocessor runs at is usually not as fast as the main cpu speed (you will have to check your computer's manual). When you know the clock speed and class (8087/80287/80387) of coprocessor you almost know enough info. Final considerations are whether you have a portable computer, in which case you want a low power (CMOS) version of the coprocessor (such as the Intel 80C287A or the IIT 2C87). If you have a 386 machine, you need to know if you have a 386sx or a "real" (true 32 bit) 386. The 386sx requires a 80387sx coprocessor.

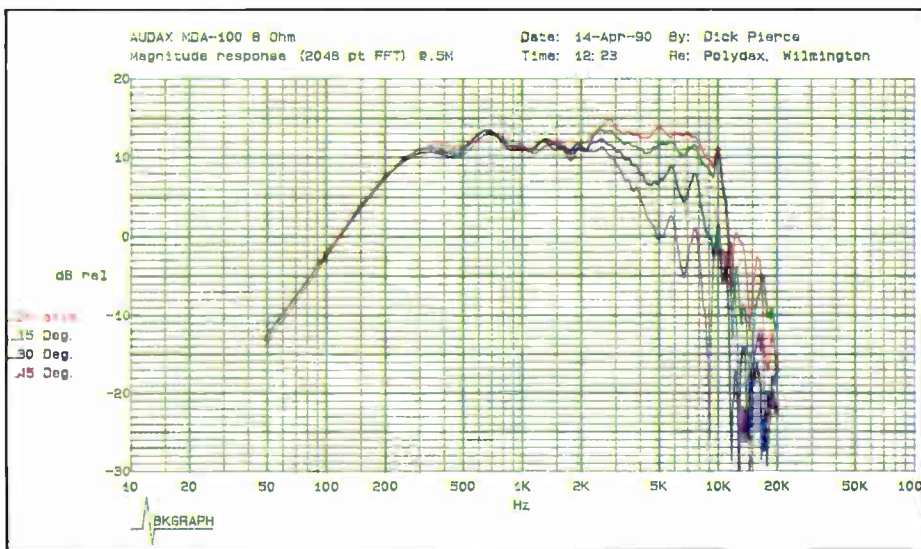
A few paragraphs earlier I mentioned that Intel has some competition. One of

the contenders for Intel's coprocessor business is Integrated Information Technology (IIT). IIT manufactures two coprocessors for 286 machines and one for 386sx machines. One 286 coprocessor is as fast as Intel's fastest version; the other is twice as fast (20 megHz)! I tried the faster device at the same speed as my Intel coprocessor (10 megHz) and the MLSSA system did most of its processing about 2x as fast as the Intel, which is what IIT claims will happen. In some cases the IIT is more than twice as fast. Remember that this performance gain is at the same clock speed as the Intel device. If the clock speed of the coprocessor is increased (not a major modification) then the speed improvement will increase. Considering that the IIT part is actually slightly cheaper than the Intel coprocessor and the IIT coprocessor is low power CMOS, I think they have a winner.

Intel apparently has not been able to find any patent violations on the IIT part and has resorted to claiming the part is inaccurate. With the MLSSA system I ran some measurements using the IIT coprocessor, computed the FFT (frequency response) and stored both the raw data and the FFT as files. I then changed coprocessor, reran the FFT using the same raw data, and then overlaid the measurements. At least with the MLSSA, I found no differences in results. About a dozen other magazines and organizations have tested the IIT part and found that it is as accurate as the Intel device. Too bad Intel!

Another coprocessor manufacturer is Cyrix. They supply a 16 MHz, 20 MHz and 25 MHz 387 coprocessors, but at a premium price to the Intel part. I have not had a chance to check out this device yet, but hope to later in this test equipment series.

Next month in this space we will continue our review of DRA's MLSSA test equipment. Part 3 consists of topics including: Using the MLSSA system for speaker design; Graphic hardcopy; BKGRAPH; Release 6.0; Microphone Calibration, Transducer Sensitivity, and Absolute SPL Measurements.



Magnitude Response.

## CAD TOPICS

(continued from page 65)

uses DSP (digital signal processing) instead of the hybrid analog/digital approach used in the TEF 10, 12 and 12+. Techron claims a more user-friendly interface with pull down menus. The cost of the Techron 20 is less than \$5,000 (less computer). A few thoughts immediately come to mind; there is an aftermarket "under belly" expansion board accessory for the Toshiba 3200 which could probably hold the TEF 20 board, and a similar arrangement could be worked up for the Mac portable. Although there are already a half dozen test systems that work with the Mac (from National Instruments, Strawberry Tree, Spectral Innovations, and others), none of these firms specifically intend their systems to be used for audio or acoustical analysis, so the TEF 20 is the only choice for Mac users. This is the most exciting development since Crown first introduced the TEF 10 and I look forward to reviewing this product before the end of the year.

Release 5.26 is the latest version of the DRA Laboratories MLSSA, with minor bugs in the STI (intelligibility) function eliminated. Accurate determination of absolute SPL levels, which are useful for both sound/noise surveys and use of the system with speaker design programs such as LEAP and CACD, is nearing completion. Aside from issues of hardware advantages/disadvantages and market acceptance, the word is that the MLSSA is a powerful and practical acoustical test system that is the easiest of the bunch to use and learn.

The most recent release of the Ariel SYS-ID has dramatically improved the user interface of the program. This is not a question of just saying that it has improved, but the program is actually reasonably "user friendly." If you have looked over SYS-ID even just a few months ago and decided to wait a while, take another look. This latest release now includes the pseudo random test signal used by the DRA MLSSA system, although this function is not working yet. The option of using both the swept sine wave now used by the SYS-ID and the MLS (maximum length sequence) signal is very useful. A swept sine wave is a potent tool to audibly detect buzzes or other spurious noises in compression drivers, woofers, cabinets or ringing in crossovers or even rooms. Another program that runs on the Ariel

hardware board is the Hyperception Signal Processing Workstation. This was a very powerful software package that acoustical and audio engineers would find very useful, except for the severe limitation that the system could only generate test signals, or receive and analyze them. Of course, a test system needs to send out the test signal and then receive it. Hyperception has just announced Hyperception II which now will generate any signal you can draw (arbitrary waveform generator) as well as analyze any system excited by the signal. (Both the Ariel Sys-ID and Hyperception Signal Processing Workstation will be reviewed this summer.) ■

## AN ALTERNATE PERSPECTIVE

(continued on page 55)

auditorium is used for overflow during special events. A video projection unit is set up in the smaller auditorium, and is fed from a camera in the main control room. Your client will love you for thinking ahead!

The last thing I would like to mention is the control room. I mentioned earlier that a good system should be user-friendly. Even the best equipment can become almost impossible if you do not design the control room properly.

Although it would be ideal if the sound system operator could sit in the middle of the room, practicality, and particularly security, dictate that it most likely will be better served housed in the rear of the hall. While a balcony location may offer an acoustical advantage, it will be harder to secure, and I can promise you will get tired of running up and down stairs just to adjust someone's mic!

I recommend that the control room house both lighting and sound control, and if space permits, a director's station. I would also recommend that all equipment be housed in the control room, except for speakers. This includes microphones, cables and other accessories. You can frame your racks out from the wall, and install a door to allow rear access. Put a piece of pegboard on the rear wall for cables, and install some shelves for mics, etc. if possible. Although there are technical reasons for having amps closer to the speakers, you can compensate for this by using heavier gauge wire. Although this may be more expensive, the convenience will be worth it. Besides, if you have an elaborate effects system, you will need to get to the amps to turn them on and off

as needed. Servicing also becomes much easier when needed. In my system, I install sliding glass doors over the racks with locks on them. This way, the operator can monitor the equipment, and at the same time keep out those who like to play.

After all of this is done, and the fat lady sings, turn out the lights and go home! ■

## CALENDAR

### Upcoming Events

#### JULY

**National Housewares Show:** Chicago, IL. Contact: (312) 644-6363. July 8-9.

**NOMDA '90 (Nat'l Office Machines Dealers Ass'n):** Las Vegas, NV. Contact: (816) 941-3100. July 11-14.

**International Association of Auditorium Managers (IAAM):** Boston, MA. Contact: (214) 255-8020. July 14-17.

**Video Expo:** Chicago, IL. Contact: (914) 328-9157. July 23-27.

**Basic Vibration Analysis Seminar:** Knoxville, TN. Contact: (615) 675-2110. July 24-26.

#### AUGUST

**International Computers in Engineering Conference and Exposition:** Boston, MA. Contact: (212) 705-7740. August 5-9.

**SIGGRAPH:** Dallas, TX. Contact: (312) 644-6610. August 6-10.

**NESDA/ISCET (Nat'l Electronics Sales & Service Dealers Ass'/Int'l Society of Certified Electronics Technicians):** Tucson, AZ. Contact: (817) 921-9061. August 6-12.

**National Hardware Show:** Chicago, IL. Contact: (203) 964-0000. August 12-15.

**Advances Vibration Analysis Seminar:** Knoxville, TN. Contact: (615) 675-2110. August 20-24.

**SC East (Int'l Security Conf.):** New York, NY. Contact: (312) 299-9311. August 28-30.

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Panasonic/Ramsa (714) 373-7278	43	212
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### Readers...

#### Contact the Manufacturers

Most suppliers are happy to provide additional information on products that interest you.

Use the Reader Service card opposite page 18, or just call the company. And when you call, say you saw it in *Sound & Communications*.

## HELP WANTED



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JBL Professional, Dept. PSN  
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## AMP TRENDS

(continued from page 47)

Bryston Vice President of Sales and Marketing Martin Bartelstone sees the new BX Series as filling a gap in the computer-controlled systems marketplace by offering a more universal, non custom-designed, job-specific package, while avoiding the pitfalls and expense at the other, overly analytical end of the spectrum.

Lectrosonics introduced a logic-controlled multi-channel power amp at the NSCA to complement the company's automatic mic mixer. The logic signals from the automatic mic mixer control the amplifier channels and dynamically gate the loudspeakers near the active microphones to improve gain-before-feedback.

QSC has become a major player in the last few years in terms of cost-effective and reliable amplifiers for contractors. After fighting higher wattage for years, the company is finally coming out with a hardy new addition to the MX Series of power amplifiers: the 750 watt into 8 ohms MX4000, which is now being tested in the field. Rear panel 'open input architecture' will allow use of second generation signal processing and a wide range of computer control, digital audio, or fiber-optic systems as they become standardized. QSC will begin taking orders on the MX 4000 in June.

JBL/Urei has recently introduced two new series of power amplifiers designed specifically for the sound contracting market, the ES Series (75-600 watts) and the lower priced but similar SR Series (150-500 watts). One of the differences between the two is the ES Series' optional external PC control RS-422 port. This system, like most multi-function computer-controlled systems, offers an advantage in large installations, such as hotels or airports, where you need to locate remote amplifiers without losing monitoring and control capabilities. The ES Series features circuit breakers and digitally controlled faders which allow the user to remote control amplifier gain via computer control interface. In the future, Urei expects to have interconnect capabilities with other modules to allow linkage of compressors, limiters, and crossover networks to the system.

The trend toward computer-controlled systems is challenging to an industry

known for its strong allegiances to proven equipment and technology. However, appropriate, judicious use of these new tools, coupled with enough knowledge and imagination to use them creatively and economically is certain to be a wise, profitable, and ultimately, unavoidable course of action. ■

## TESTING & MEASUREMENT

(continued from page 58)

use the TEF analyzer to measure where the acoustic origins are located. Using the relative mode of the cursor function, find the separation between the two origins.

Using a precision signal delay device, dial that difference into the device. Caution: be sure that your digital delay device has a reference output so that you do not have to measure the internal delays through that device's ADC and DAC. Dialing in the appropriate delay to the advanced drivers should result in:

- A rise of nearly 6 dB on the ETC.
- Both signals arriving at the same time.
- A much smoother frequency response over the entire overlap area.
- Proper polar response behavior by each device.

### CORRUPT SOURCES

In the concert sound business, we see large arrays of loudspeaker systems elaborately aligned physically in arc-shaped patterns. One of the problems frequently overlooked is that while each module is reconciled with the others, the modules themselves are corrupt.

### TIME ALIGN

Time Align is the registered trademark of Edward Long. It refers to multiway systems that have been adjusted via both physical and passive network technology to a smooth phase response over the widest coverage angle possible with the devices chosen. This is the area of corruption in so many "packaged" systems used in large arrays. You can physically align the arrays, but what you then have is a corrupt array due to its components rather than its assembly.

### A CHECK LIST

- Find the acoustic origin.
- Find the acoustic centers.
- Find the acoustic wavefront emission point.

- Check the phase response through the crossover region.
- Check the phase response through the listening area for any multiple devices in the 500 to 5000 Hz range.
- Attempt to keep crossovers out of that critical frequency range.
- Replace incompatible devices.

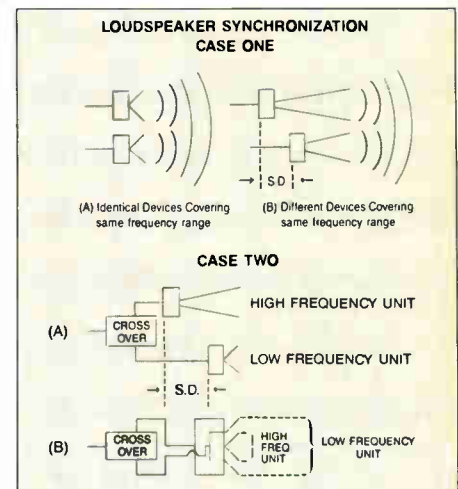


Figure 9.

### A FEW BASICS TO ALWAYS KEEP IN MIND

Equalizers and precision signal delay devices cannot change room acoustics. We appreciate that certain people say that they can but that does not make it so.

EQ and precision signal delay devices, (PSDD) can often help reduce the interaction of the direct sound with the space they are installed in, but only if the correct directivities for the horns are chosen first and the EQ or PSDDs are simply restoring that directivity back to normal after they have been incorrectly adjusted.

Signal processing can process only the direct sound from a system and never the early reflected or late reverberant. If you have trouble understanding that, take the time to carefully think it through — it's absolutely fundamental!

### SUMMARY

Signal Synchronization has measurably improved intelligibility scores in overlap zones between near-throw and far-throw horns from over 10 AL%cons to less than 6 AL%cons.

In another case, synchronization brought about 10 dB increased acoustic gain. Signal synchronization can often significantly reduce early decay time, ED. This is one of the primary reasons speech intelligibility improves in the Sig Synch area. ■



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To keep operation of the ES Series ultra-cool and ultra-quiet, all models incorporate a continuously variable fan system that senses heat sink temperature and alters fan speed accordingly.

The ES Series uses front-panel LEDs to give you operational status at a glance. The modular construction of ES Series, plus JBL's distinctive two-piece case design, allows you to swap amplifier channels in less than five minutes. Plus you get a defeat switch to prevent accidental or unauthorized level adjustment.



Another feature of the ES Series is High Frequency Power Conversion resulting in a dramatic reduction in weight for a given power output. How dramatic? The ES1200 for example delivers 600 watts per channel into 4 ohms yet weighs only 39 pounds.

So, the next time you sit down to spec-in amplifiers, from 75 to 600 watts per channel, just remember two things, JBL has the right amp for your application, and JBL is in the amp business to stay.



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