History of *The PA Bible*, Its Reincarnation, Plus Document List and Subject Outlines

By Jim Long, Telex Communications, Inc.
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Note from the author: in July of 1963, I started with Electro-Voice, Inc., in Buchanan, Michigan, as an engineering tech "intern." Other than continuing my education, I never left the company. In the late 1960's, I moved from engineering to marketing and have been involved in sales or marketing ever since. I recall with some vividness the creation of *The PA Bible*.

EV's *The PA Bible* is a 16-page document issued in 1979, followed by 19 "additions" issued over a 19-year period on various pro-audio product and applications subjects. The documents were printed in EV's in-house print shop and mailed all over the world at no charge. A few years after the last addition, a bound version of the documents was made available. All versions have long been out of print, but requests continue to come in. Some documents have appeared on the Internet from time to time, of varying quality and longevity, some free and some not. We are happy to now make them all available on the Electro-Voice Web site (www.electrovoice.com). We have discussed from time to time the updating of the documents, since the products used as examples are no longer available. In the end, we decided to reissue them "as is," feeling that the information was in nearly all cases as relevant now as it was some years ago. A few updating and clarifying comments are in the outline section starting on page 3.

Musicians who needed PA's were the target audience for *The PA Bible*. Quoting from the original document, "In this guide we'll address those basic problems, annoyances and questions that plague every musician at one time or another." However, *The PA Bible* and many additions were relevant to those involved in fix installations as well.

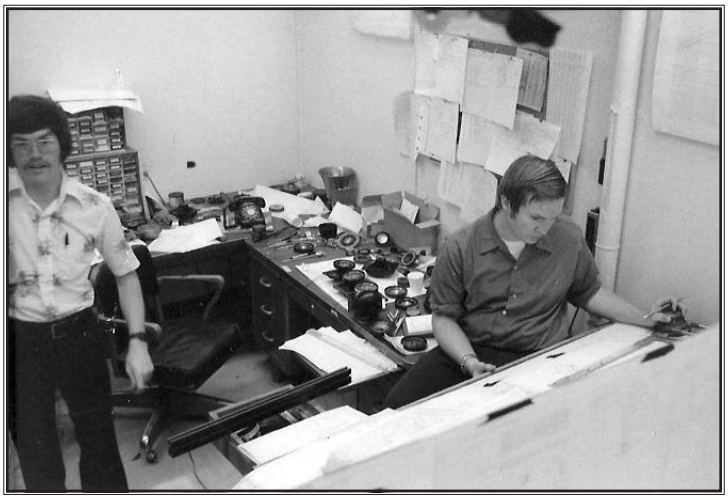


Figure 1. Jeff White (left), author of *The PA Bible*, with Kent Frye, key compression-driver engineer, circa 1977.

The PA Bible, covering "what's wrong with a lot of PA's" and a "basic approach to system design," was largely written by Jeff White, a young loudspeaker engineer who worked at EV from 1976 to 1981. See Figure 1. Jeff worked for Ray Newman (1940-1996), then EV's chief loudspeaker engineer who made a number of major contributions to our industry, including the basic concepts for the design of the now-ubiquitous constant-directivity high-frequency horns and the application of the analyses of A. N. Thiele and R. H. Small to the design of vented low-frequency loudspeaker systems. Jeff set the lighthearted-yet-informative tone of the document and subsequent additions, and wrote a number of them. I also recognize the writing style of Ray in some. I recall being pretty heavily involved in the editing process of many of the documents. Others contributed too.

Recalling the creation of the *The PA Bible*, Jeff, now a loudspeaker consultant in Southern Indiana, wrote in a December 2006 e-mail (slightly edited by the author):

I still have my **original** text that was hand typed 78 pages…with hand drawn images that were recreated by the EV art dept. …The original working title of the thing was:

Using Electro-Voice Components to
Improve Your P. A.

A guide from Electro-Voice Engineering on applying our building-block group of horns, drivers, bass-boxes and crossovers to make high-performance sound reinforcement systems.

Well, the main thing that comes to mind when remembering the nights at home drafting this was sitting at my dining room table typing it out and listening to Supertramp's 1979 LP (vinyl!!!) release of "Breakfast In America." I think I was turned onto Supertramp by you with the Stan Ricker re-master of Crime of the Century ("Bloody Well Right") at one of the AES Conventions. Oh well, lots of good memories now. I'm pretty sure I did some cursing at the time with the extra work involved.

Whose idea was *The PA Bible*? This may be lost in audio history, but in recent communication both Jeff White and I recall that EV's president of the day, Bob Pabst, was very high on the idea of educating our dealers and end users with white-paper-type documents so they would want EV components for their PA. Jeff and I don't recall who came up with the name, but it sounds like something Ray would do. Jeff says for certain that Ray was motivation, inspiration, support and concept. Jeff characterizes himself as author/grinder and basic layout of material. He labels me as renovate, rearrange, revise and transform.

Document List

All documents are listed below in Table 1. Following that, a subject outline with selected comments is given for each document. This may facilitate the choice of documents to download.

Titles	Pages	Date
The PA Bible	16	1979
Addition Number One: Drivers and Horns	4	1979
Addition Number Two: Power Handling Capacity	4	1979
Addition Number Three: Microphone Types	4	1980
Addition Number Four: Understanding Equalization and the Various Types of Equalizers	8	1980
Addition Number Five: System Interconnection	6	1980
Addition Number Six: The Con'·stănt Di·rec·tiv'i·ty White Horn Paper	4	1980
Addition Number Seven: Crossovers and Biamping	4	1981
Addition Number Eight: Microphone Techniques	6	1981
Addition Number Nine: Mixing for the Live Performance	4	1982
Addition Number Ten: A Central Cluster System for Rock and Roll	4	1982
Addition Number Eleven: Portable Sound Systems for Small Clubs	4	1982
Addition Number Twelve: "Force®" Boxes for Music Systems	3	1983
Addition Number Thirteen: The Electric Guitar Loudspeaker, a Unique Design	3	1983
Addition Number Fourteen: Loudspeaker System Types	4	1984
Addition Number Fifteen: Barrier Miking	3	1985
Addition Number Sixteen: Mismatching Drivers and Horns	4	1986
Addition Number Seventeen: What is Manifold Technology™?	3	1987
Addition Number Eighteen: Controlled Systems	3	1991
Addition Number Nineteen: Condenser Microphones	3	1997

Table 1. Titles, pages and dates for *The PA Bible* and additions.

Detailed Subject Outline with Selected Comments

The PA Bible (16 pages, 1979)

In the "Double Distance Rule Gets You" section on page four, line ten, "decreased" should be "increased." This mistake was mentioned at the end of the second addition but never corrected in *The PA Bible* itself. Don't miss the two dudes in Figure 16:

1. Table of Contents
2. Is Electro-Voice going into the publishing business?
3. How to read this guide
4. What this booklet is about
5. What's wrong with a lot of PA's
   A. Low-efficiency speaker systems
   B. Not enough amplifier power
   C. Poor frequency response
   D. Highs miss half your audience
   E. Double-distance rule gets you
   F. Room reverberation swamps your voice
6. Basic approach to system design
   A. Small size room
   B. Medium size room
   C. Large size room
   D. Monitor systems
   A. Some thoughts on permanent installation systems

Addition Number One: Drivers and Horns (four pages, 1979)

1. Driver introduction
   A. The diaphragm
   B. The phasing plug
   C. High-frequency output roll-off
   D. Choosing your high-performance driver
2. Horn introduction
   A. Basic forms of horns
   B. Constant-directivity horns
   C. Selecting your horn

Addition Number Two: Power Handling Capacity (four pages, 1979)

1. Loudspeaker parts and operation
2. How power destroys loudspeakers
3. The relationship between thermal and mechanical failure
4. The rating game
5. Test signals
6. A meaningful test
7. Efficiency vs. power capacity or want to buy a 400-watt loudspeaker?
8. How big an amp can I use with my speaker?
   A. Multi-way systems
      i. To use a speaker system to full capacity
      ii. A more conservative, "nominal" amp size
      iii. To be very conservative
   B. One-way systems
      i. Musical instrument speakers
      ii. Bi-amped and tri-amped multi-way systems
9. Vitamin C for loudspeaker life extension

Addition Number Three: Microphone Types (four pages, 1980)

This Addition was based on *The Microphone Primer*, written for musicians circa 1968 by Jim Long and an executive of the Ludwig Drum Company, who at the time was distributing EV products to music dealers. Even as basic as it was, Lou Burroughs, EV's "Mr. Microphone," handed out this primer in his professional broadcast and recording seminars.

1. Microphone types and operation
   A. Ceramic and crystal generating elements
   B. Ribbon (or "velocity") generating elements
   C. Dynamic generating elements
   D. Condenser generating elements
2. Microphone pickup patterns

A. Omnidirectional pickup pattern
B. How does an omnidirectional microphone work?
C. Why an omnidirectional microphone?
D. Unidirectional pickup pattern
E. How does a unidirectional microphone work?
F. Why a cardioid microphone?
G. Two vastly different types of cardioid microphones

3. Microphone frequency response
4. Microphone impedance
   A. Choosing between low-Z and high-Z microphones
5. How to choose the right microphone
6. Operating tips
   A. Impedance matching for dynamic microphones
   B. Connecting the microphone to the mixer input
      i. Hi-Z cable
      ii. Lo-Z cable and inputs
   C. Avoiding multiple-microphone interference

Addition Number Four: Understanding Equalization and the Various Types of Equalizers (eight pages, 1980)

Material for this addition was supplied by Larry Blakely, a well known audio and recording industry consultant and writer of the day. His material was edited and augmented by Jeff White and Ray Newman. Page 8, very briefly, mentions room equalization using a real-time analyzer, which can only measure the total sound field in a room. 1980 was of course a long time before the currently popular PC-based analysis systems, which can under the proper conditions provide quasi-anechoic information, with a more useful predominance of the loudspeaker's direct field.

1. Introduction
2. Frequencies
3. Octaves
4. Fundamentals and harmonics
   A. Sub-sonic frequency range – 1 Hz to 20 Hz (approximately 4 octaves)
   B. Very low bass frequency range – 20 Hz to 40 Hz (1 octave)
   C. Bass frequency range – 40 Hz to 160 Hz (2 octaves)
   D. Lower mid frequency range – 160 to 315 Hz (1 octave)
   E. Mid frequency range – 315 Hz to 2,500 Hz (3 octaves)
   F. Upper mid range or presence frequency range – 2,500 Hz to 5,000 Hz (1 octave)
   G. High frequency or brilliance frequency range – 5,000 Hz to 10,000 Hz (1 octave)
   H. Extreme high frequency range – 10,000 Hz to 20,000 Hz (1 octave)
5. Equalizer characteristics
   A. Shelving
   B. Peak/dip
6. Basic types of equalizers and their applications
   A. Tone controls
   B. Two knob equalizers (selectable frequency)
   C. Three knob (three frequency) fixed frequency equalizer
   D. Four knob equalizers (fixed and selectable frequency)
   E. Graphic equalizers
      i. ISO center frequencies
      ii. One octave graphic equalizer
      iii. 1/3 octave graphic equalizer
      iv. 1/2 octave graphic equalizer
   F. Sweepable frequency equalizers
   G. Parametric equalizers
   H. Paragraphic equalizers
7. Basics for the use of equalizers
8. Know the fundamental frequencies of voices and musical instruments
   A. Vocals
   B. Electric bass
   C. Drums
      i. Bass drum
      ii. Snare drum
      iii. Tom toms

iv. Cymbals
9. Room equalization (room voicing)
10. Do not use equalization to excess

Addition Number Five: System Interconnection (seven pages, 1980)

Some topics are perhaps by now superfluous, e.g., (1) discussion of high-impedance microphones, which have essentially disappeared from the scene, (2) the overloading of microphone inputs, largely a thing of the past given today's input trim pots and (3) the use of 1/4-inch phone plugs for portable speakers, largely replaced by the Neutrik Speakon® connectors. Also, the discussion of decibels does not describe the dBu, today's most common method or rating the voltage output of mixers and line-level electronics (0 dB = 0.775 volts).

1. Interconnecting the system
2. Low level connections
   A. Attenuators
   B. Impedance
   C. Phantom connection
   D. Connectors
3. Line level connections
   A. Balanced versus unbalanced
   B. Interference pickup
   C. System ground
   D. Crossovers
4. Power amplifier connections
   A. Load impedance
   B. Polarity
   C. Output impedance matching transformers
5. Definitions
   A. Decibel (dB)
   B. dBV
   C. dBm
   D. Active devices
   E. Passive devices
   F. Impedance
   G. Ground loop
   H. RFI
   I. SCR hash
   J. Signal

Addition Number Six: The Con'·stănt Di·rec·tiv'i·ty White Horn Paper (four pages, 1980)

This addition is a great way to find out how horns can be made to spread sound evenly over a wide frequency range. The statement in the last paragraph of the "'Constant Directivity' Defined" section, "varies from here to Newport, Tennessee," refers to the distance between the EV headquarters in Buchanan, Michigan, and the loudspeaker plant in Tennessee (high-performance compression drivers were made in Buchanan). A Jeff White contribution.

1. "Constant directivity" defined
2. What constant directivity horns do for you
   A. Constant directivity horns give a well defined zone of coverage that you can count on
   B. You can use fewer constant directivity horns
3. What makes a constant directivity horn?
   A. A constant directivity horn is fed by a small opening
   B. A constant directivity horn has straight sidewalls over a major portion of its length in both the horizontal and vertical planes
   C. Constant directivity horns have an additional wide-flare section near their mouth openings
   D. Constant directivity horns are usually bigger than conventional horns
4. A driver on a constant directivity horn needs equalization
   A. The Newman Criteria for drivers
   B. Horns affect driver output
   C. Utopia by equalization!
5. Do constant directivity horns require any other special equipment?
6. Why are there a number of different constant-directivity horns?
   A. Coverage angle
   B. Minimum crossover frequency
   C. Minimum frequency for coverage angle control

Addition Number Seven: Crossovers and Biamping (four pages, 1981)

The last paragraph on page 2 tells how the high-frequency distortion products of power-amplifier clipping can destroy the high-frequency sections of passively crossed over speaker systems. This is probably much less likely today because internal protection devices are now so common. Page 4 talks about over equalization sending speaker parts to Hobart, Tasmania (third paragraph). That's not an old EV plant location but the southernmost city in Australia. Another Jeff White contribution, along with sending the speaker recone guy to Hawaii (page 3, third paragraph).

1. Crossover frequency and slope rate
2. Types of crossovers
   A. "Passive" crossovers
   B. "Active" crossovers
3. What to use – active or passive?
4. Why biamp?
5. Pointers for speaker biamping
6. Connecting thoughts

Addition Number Eight: Microphone Techniques (six pages, 1981)

Section I

1. Directional microphones
2. Non-directional microphones
3. Frequency response
4. Proximity effect
5. Placement
   A. Angle
   B. Distance
6. Number of microphones
7. Hints and other miscellany
   A. Elimination of distracting signals
   B. Special microphones
   C. Some general guidelines

Section II

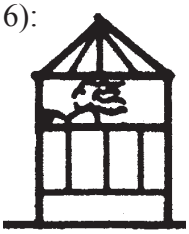
1. Vocalist microphones
2. Electric/bass guitar pickup
3. Piano microphone
4. Acoustic guitar
5. Drum microphones
6. Conclusion

Addition Number Nine: Mixing for the Live Performance (four pages, 1982)

1. Introduction
2. The mixer
3. Planning
4. The set-up
5. The performance

Addition Number Ten: A Central Cluster System for Rock and Roll (four pages, 1982)

In the System Adjustment section, his addition describes loudspeaker level setting and equalization done with a three-mic level averager operating in real time, a useful technique mostly lost in these days of software-based analysis systems. According to Jeff White, the end result had quite an effect on the sound guy's hair (Figure 6):



1. Split stacks
2. Single cluster
3. The equipment
4. System adjustment
   A. Step 1 (setting levels and EQ of short throw)
   B. Step 2 (adding mid-throw horn)
   C. Step 3 (adding long-throw horn)
5. Overall coverage and response uniformity
6. Sound pressure levels

Addition Number Eleven: Portable Sound Systems for Small Clubs (four pages, 1982)

In the "A System for Today" section, this addition describes the EV Entertainer system consisting of two compact, lightweight two-way speakers systems (100S) and a powered mixer. The 100S was the precursor of today's Sx100+ and Sx300.

1. Some history
2. The needed system
   A. What are the criteria of portable equipment?
   B. How much sound is enough?
   C. What frequencies should be covered?
   D. How can we get this good sound to all seats?
3. A system for today
4. Addendum

Addition Number Twelve: "Force®" Boxes for Music Systems (three pages 1983)

"Force" was the moniker applied to EV's "high value" line of musical instrument loudspeakers, less expensive than the original SRO® and subsequent EVM® lines. Designs were based on the vented-box analyses of A. N. Thiele, which first appeared in the US in 1971 issues of *Journal of the Audio Engineering Society.*

1. Introduction
2. Enclosure designs
3. Construction suggestions

Addition Number Thirteen: The Electric Guitar Loudspeaker, a Unique Design (three pages, 1983)

1. The guitar sound approach
2. The special sound quality
3. Cone
4. Coil
5. Dome
6. Gap structure
7. Power handling capacity
8. Power test
9. Venting
10. Cabinets
11. Conclusion

Addition Number Fourteen: Loudspeaker System Types (four pages, 1984)

This addition reads like Ray Newman. Ray was very fond of the "system interrelationship equation" discussed on page 3, second column.

1. Introduction
2. What is a system?
3. Common types of systems
   A. Dipoles
   B. Sealed boxes
   C. Vented boxes
   D. Horns
   E. Combination boxes (horn midrange and vented bass)
   F. Combination boxes (horn bass and sealed box midrange)
4. The Thiele/Small connection
5. Comparing system types
6. Summary and application comments

Addition Number Fifteen: Barrier Miking (three pages, 1985)

1. Introduction
2. Early discoveries
3. Solving the problem
4. Further developments
5. Common questions
6. What is barrier miking?
7. When should barrier miking be considered?
8. What are some typical instrument miking applications?
   A. Piano miking
   B. Drum miking
   C. Miking stringed instruments
9. I've heard that a microphone mounted on a barrier is more sensitive than the same microphone mounted on a stand. How is that possible?
10. What effect does carpeting have on the performance of a barrier-mounted microphone?
11. I've read about using Plexiglas and

plywood panels to improve mic performance.
12. What type of microphones can be used in barrier miking?

Addition Number Sixteen: Mismatching Drivers and Horns (four pages, 1986)

This addition includes a table showing some popular competitive compression drivers of the day (1986), showing diaphragm construction, compression ratio, coil diameter and throat (exit) diameter. *Note: the graphs in Figures 12 and 13 do not appear to match the text just above them.*

1. Introduction
   A. In a jam and/or the show must go on
   B. Availability and "equivalent units" on a sound system "spec"
   C. Listener preference
   D. Some existing equipment on hand
2. Loudspeaker mechanisms
3. "Small format" drivers
4. Large-format drivers
5. Throat adapters
6. Conclusions

Addition Number Seventeen: What is Manifold Technology™? (three pages, 1987)

This addition applies to EV's first "concert sound" systems, the MT-4 two-box, four-way system consisting of the MTH-4 HF box and the MTL-4 LF box.

1. Manifold Technology benefits: more from less
2. Inherent engineering problems
3. Some solutions
4. Some specific realizations
5. Where does all this lead?

Addition Number Eighteen: Controlled Systems (three pages, 1991)

This addition applies to EV's DeltaMax™ compact controlled or processed systems, analog precursors to the contemporary EV Xi-1122A/85F and Xi-1152A/64F systems with digital signal processing.

1. What are controlled systems?
2. Why are such systems of interest and where do they apply?
3. What is being controlled and what are the consequences?
   A. Amplifier gain
   B. Peak limiting
   C. Dynamic frequency response tailoring
   D. Crossover frequency shifting
4. The future of this technique
   A. Box characteristics
   B. Woofer characteristics
   C. High frequency section characteristics

Addition Number Nineteen: Condenser Microphones (three pages, 1997)

This "last hurrah" addition was written to highlight the advantages of EV's then new RE2000 large-diaphragm voltage-biased "true condenser" mic, introduced by EV to compete in the high-end recording market.

1. Introduction
2. The principle of condenser microphones: changing capacitance and biasing
3. What is biasing?
4. The four types: diaphragm electret, back electret, voltage-biased (true condenser) and rf biased
5. How the different types of condensers are biased: electret designs – two types
6. Voltage biased
7. rf biased
8. Condenser microphone and the environment
9. Conclusion