

Many of our industry's best-known trademarks are the result of this audio giant.

ED LONG: BREAKTHROUGHS & DEVELOPMENTS

By Mary C. Gruszka

Edward M. Long is probably best known to the audio and recording industry as the inventor of Time Align monitors, Nearfield Monitoring, Pressure Recording Process microphones and ELF extended low frequency bass systems.

What may not be known is that these developments came from his enormous research and development work on loudspeaker drivers and microphones, and his insatiable curiosity to find out how things work and to have fun doing it at the same time. When he can't find the answers from books or other "experts," he figures things out for himself, often in collaboration with friends. A holder of numerous patents and trademarks, he takes a fresh look at problems and comes up with unique solutions.

"Ed Long is a true pioneer in the indus-



Photo by Allison Long

try with developments in many different fields. He has pushed the industry forward and is always striving for excellence and quality," says studio designer Chips Davis.

Working in his basement lab in his Oakland, CA, home overlooking a canyon (where he occasionally holds intensive loudspeaker design workshops), Long writes; reviews turntables, cartridges and styli, and headphones for *Audio* magazine;

consults; teaches and is a great story teller.

WHERE IT ALL STARTED

Hailing from Rochester, NY, Long had been interested in math and science back in high school.

"I bought the freshman chemistry book that was used at the University of Rochester," he says. "It went into more detailed explanations. I need to know more about stuff."

He attended St. John Fisher College and worked as a lab assistant in the research lab at the Eastman Kodak Company, in Rochester. His work at the lab turned out to have a round-about influence in getting

him involved in audio.

First, although the lab was doing some interesting research, after about six or eight months on the job, Long decided that he didn't want to be a chemist. "That was more like being a glorified cook," he says.

But what to do? Fortunately (for the audio industry), he was introduced to "high fidelity sound" by one of the researchers

Mary C. Gruszka is the owner of MCG Audio Consulting, a New York-area company specializing in TEF analysis, systems design and acoustical consulting.

who was working with him.

"I remember hearing a recording of Les Paul through an Altec 604 system, driven by a home-built amplifier and fed by a Pickering magnetic cartridge mounted in a Garrard record changer," he recalls. "I wanted to obtain a record player that was, what I considered, to be 'above average,'" he continued. "In an Allied Radio catalog, I found a General Industries turntable that had not only a tonearm and cartridge, but a separate arm with a cutting head to make records."

He ordered the turntable with a crystal cutting head, because his brother knew where he could find a used amplifier with a high impedance output. "We bought some Wilcox-Gay recording blanks and made many records." Ed's brother, who made a beautiful case for the system, still has it today. That turned out to be the beginning of a life-long interest in audio.

"I continued to develop a love for audio and soon had my first home-built tape recorder, which used a Tapemaster transport," he says. "Later, I bought a 16-inch Presto cutting turntable to which I fitted a Rek-O-Kut overhead lathe. I rebuilt a Presto IC cutter head and drove it with an all triode, Class A power amplifier, which I designed and built. This led me into the commercial record business and I made many records for clients such as Rochester area schools and organizations, and even for the museum exhibits."

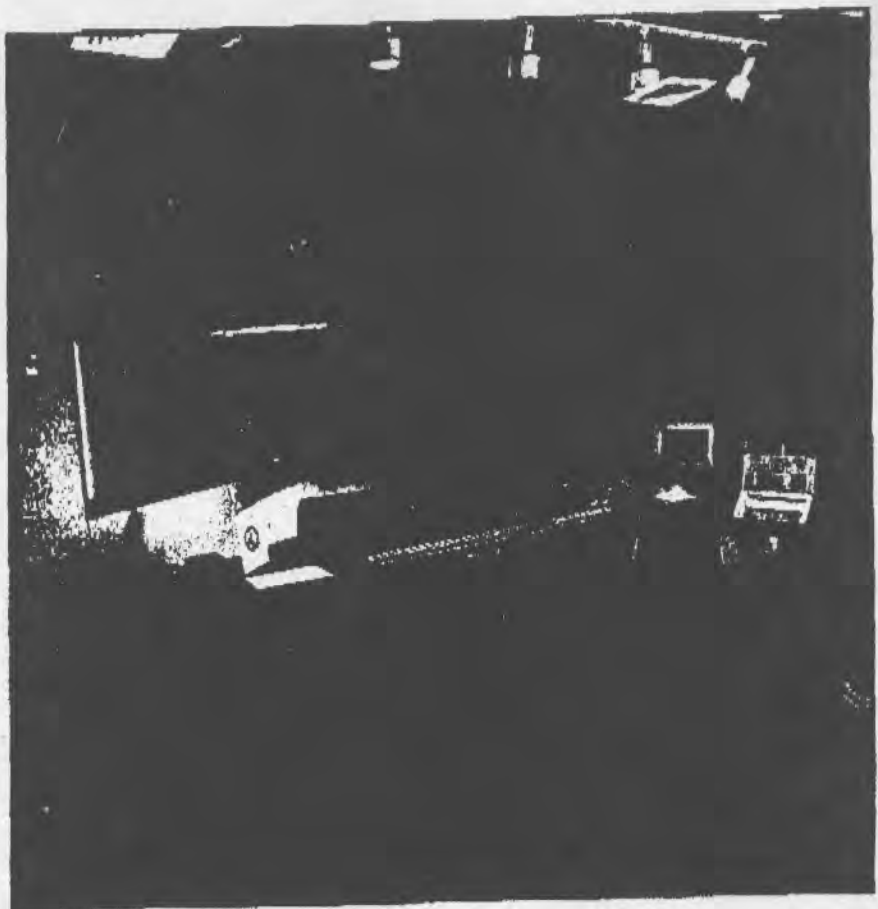
Long says that he taught himself what he needed to know about amplifier, tape recorder and cutter head design. "I learned by reading and experimenting. I would look at a schematic and draw in the waveform that I expected would be at a certain point, and then verify it. It was like a game. This wasn't just work; I realized I could be having fun with this stuff."

His education was enhanced while he was in the Army during the Korean War. He attended Microwave School at Ft. Monmouth, NJ, where he eventually was assigned as an instructor, teaching microwave and FM theory, and pulse coded modulation systems.

After the Army, he began his career in engineering at the Eastman Kodak Naval Ordnance Division, working on projects such as the test systems for the sidewinder missile components. He later helped develop for other companies such diverse products as an ultrasonic beverage foamer, a dimmer control system for fluorescent lights, an SCR tester and a high intensity sound system for aircraft component testing.

PROFESSIONAL AUDIO

Long's professional audio career began when he joined the Stromberg Carlson Co., which was forming an amplifier design group and were hiring engineers to



The CRM-100 monitoring system at Paradise Sound, Index, WA.

join it. When he applied for the job, one of the questions on the application form was, "Why do you want to work for Stromberg Carlson?" Long's reply: "It is obvious from your products that you need help."

"I thought I'd never get the job," he says. "But the person who hired me said that

voted to research in acoustics and psychoacoustics.

"We had an anechoic test chamber and a large assortment of Bruel & Kjaer and other measuring equipment, including a phase meter." (Yes, he was measuring phase as early as the 1960s!)

"I consider this experience to be invaluable in my work in loudspeaker design," Long says. "As an example, we measured loudspeakers the usual way, like everyone else, using decibel and frequency scales. When we tried to correlate the objective measurements with information we collected from subjective listening tests, we had difficulty seeing why people selected certain loudspeakers over others. When we converted the amplitude vs. frequency response data to loudness and pitch scales, these choices became very clear. The lights went on, so to speak."

He became hooked on loudspeaker design. "In many of the projects," Long says, "I noticed that most of the other engineers had little interest in the loudspeaker part. I was fascinated by the idea that we could expect to reproduce the sound of a symphony orchestra by a device that used a piece of paper, a coil of wire, some steel and a magnet. It is rather incredible when you think of it like that. As I learned more and more about loudspeakers, slowly but

"I was fascinated by the idea that we could expect to reproduce the sound of a symphony orchestra by a device that used a piece of paper, a coil of wire, some steel and a magnet."

I was exactly the kind of guy that they wanted."

When Long joined the company, the amplifier group wasn't quite ready to begin work, so he spent his first few months working with a special group that was de-

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surely, I became known as 'the loudspeaker expert,' and my colleagues would turn to me for information."

Long always insisted on listening to anything he (or his colleagues) designed. He related the story of a colleague who had just finished an exhaustive series of polar measurements on a driver, and once finished, realized that the curves looked terrible.

"I asked him, 'Did you listen to it? What does it sound like?' He could have saved himself the time of making all those measurements had he listened to the tweeter. It was obvious that there was something wrong."

ON TO CTS

Later in his career, Long went to CTS of Paducah, KY, which was the country's largest OEM loudspeaker driver manufacturer during the 1960s.

At CTS, Long learned to tailor designs for diverse applications such as commercial aircraft, communications, radio and television receivers, portable phonographs and tape recorders, and high fidelity systems. He designed drivers for such companies as Zenith, Motorola, Sylvania, Scott, Fisher, Harmon-Kardon and Ampex.

While at CTS, he worked with Bob Gault, who later founded Eminence Speaker Corporation, and Jim Novak, who developed the worksheet form for doing loudspeaker design that Long used.

"I used his format to write some computer programs to calculate volumes and resonant frequencies," he says.

Long now had the opportunity to actually develop and build some of the drivers that he had been thinking about even before he joined CTS.

"I made them, tested them, adjusted the formula, and tried again," he said. "I made some of the actual cones myself. I took the material and put it in the beaters to make the slurry, adjusted the pH, etc. to make special stuff. I had fun with it."

In the process, he kept volumes of notebooks on his experiments and developed charts that are available nowhere else. After his stint at CTS, Long joined Ampex, a company that he long admired, in the the consumer audio division in Chicago. Other jobs brought him to California, where he eventually established his own businesses, E.M. Long Associates and Calibration Standard Instruments, which he still operates.

MIXDOWN MONITORS

One of the first products to come out under his own company's banner was the Nearfield Monitor.

"Because I was interested in knowing more about the program material that my loudspeaker designs were intended to reproduce, I made many recordings so I

could better understand the relationship between recording and reproduction," Long says. "This led me to design a monitor which I could use when I made recordings."

"Because the acoustics of the spaces where I set up my recorder were usually so bad, I designed my monitors so that I could sit close to them. I discussed recording techniques with professional recording engineers and, in trading information, they became aware of my monitors. I began making the MDM-4 monitors for them."

"The designation MDM-4 stands for Mix Down Monitor 4-channel because the early users were engaged in 4-channel recording, as was I. I came up with the trademarks Nearfield Monitor and Nearfield Monitoring; a written description for the requirements had to be met. Just placing a loudspeaker close-in isn't enough to meet the requirements." (Interestingly, Long is once again involved with 4-channel reproduction, but this time it's for surround-sound.)

ED SPEAKS UP

Using your ears: "It is important to listen to what you are testing. While at CTS, I once showed a client a driver with a flat frequency response that sounded terrible. It turned out that the voice-coil was rubbing. So a flat frequency response isn't everything. A measuring mic has no taste whatsoever, it just measures the sound pressure."

"But at the same time, you can get fooled on listening tests too. Change the placement of drivers in the room, or change your position in the room. You can hear that."

Loudspeaker measurements: "A problem with measurements is that you can measure a circular loudspeaker four times, rotating it 90°, and get different curves each time. A "round" speaker is not necessarily symmetrical."

Creating a matched set of loudspeakers: "Each loudspeaker is different. To get two loudspeakers close together, run curves on the drivers and then hand-select them. Then you can guarantee that they will be the same for awhile."

The importance of phase overlap (at the crossover region): "The overlap can't be trivial. It is not just a matter of making the crossover frequency flat. You need to do it over a range, especially if you are using mass-produced drivers with a toler-

TIME ALIGN MONITORS

Following the development of the Nearfield Monitor came another significant design, the Time Align loudspeaker system. Papers by Dick Heyser in the AES Journal caused him to think about the time offsets in multi-way loudspeaker systems. He became interested in Time Delay Spectrometry (TDS), which provided a way to delay the spectrum analyzer to compensate for the microphone-to-loudspeaker distance. In his design work, Long noted that crossovers didn't work the way he would have predicted.

"I knew something wasn't quite right," he says. It turned out that "you need to know what the filter does in the time domain. Although TDS operates in the frequency domain, I wanted to see things in the time domain; this resulted in the Time Align generator and display, which I used to design loudspeaker systems."

"I came up with the concept of the Time Align generator and Ron Wickersham breadboarded it. It uses bucket brigade delays and an outside clock oscillator, and

ance for the phase shift. With mass-produced products, you should get phase overlays reasonably good for over an octave. For most loudspeaker designs, the two phase curves from the woofer and tweeter don't come together."

Differences between monitors and consumer loudspeakers: "There has to be a difference between loudspeakers intended to be used as monitors and consumer loudspeakers that are used for listening. The monitor must allow excellent program material to sound excellent and bad program material to sound bad. A consumer loudspeaker, to be successful, must make excellent program material sound good and bad program material sound acceptable. A recording engineer needs to hear the bad sound so he can fix it; a listener can't do anything about the program material, so the loudspeaker should ameliorate the bad sound and make it acceptable."

"The majority of consumers just want 'nice sound' and the successful companies are the ones who realize the deficiencies of many recordings and take this into account in their loudspeaker designs. This is not just idle speculation on my part. It has been demonstrated by monitors and consumer loudspeakers designed by me and others as well." ■

I still use it to this day. I've used this system to design a number of consumer and professional loudspeaker systems, including the Sonex Two, the UREI 813, and the CSI MDM-TA2 and MDM-TA3."

At the time Long was doing his first Time Align designs (in the early 1970s), a self-contained, single unit TDS or TEF analyzer was not yet available. Now he also uses the Techron TEF analyzer to verify his designs. "I use it especially to show the phase overlap of two drivers," he says.

His first Time Align product was a consumer loudspeaker system, developed about 1975. This resulted in interest from UREI, and a reacquaintance with the Altec 604 coaxial driver.

Bill Putnam, of UREI, Coast Recorders, United Recorders and Quad Eight Studios fame, sent Long an old gray cabinet outfit with an Altec 604E.

"I built a Time Align network for it, and we listened to it and it did sound more realistic," Long says. After the successful demo, he and UREI started on the project.

"We started with 604Es and ended up with 604Gs. But I have a crossover design for the 604Es, if anyone is interested." Long also designed the 15-inch bass driver for the original 813s, but after JBL

bought UREI, the most recent version makes use of a JBL woofer. The first UREI 813 came out about 1976.

After the UREI project, Long developed a time-aligned monitor system under his own company.

"The audio world is a better place, thanks to Ed's creative achievements."

"The MDM-TA3 came about because people were asking me why I didn't have a time-aligned monitor of my own," he says. "The MDM-4 was in fact less than 100 microseconds off, which is good, but I didn't feel that I could call it a Time Align Monitor. So I developed the MDM-TA3, a smaller and less expensive loudspeaker that could be soffit-mounted. This came out in 1979."

Long had also built a smaller Time Align monitor system for himself that was

housed, along with a power amplifier, in a portable case that folded up. His inspiration hearkened back to a set of Ampex portable speakers that went with the 600 recorder. He used his prototype during his experiments "to check out mics and other things."



"The MDM-TA2 evolved from the portable speaker project and was finally brought out in 1982, when I had it right."

The MDM-TA2 has some features that are quite unique. First, it has a metal cover that adheres to the front face of the enclosure.

"Because the loudspeaker produces vibration energy other than acoustical, this helps to subdue transmission of that energy out of the box," Long says. The MDM-TA2 also has a 3/4-inch dome tweeter that provides smooth frequency response off-axis.

Two of the other interesting features are the absolute acoustical polarity switch, and the "program/position" switch, which adjusts the high-end equalization to compensate for both listening position (Nearfield Monitoring or distant) and program source (original or final).

The latter switch was incorporated in the design of the MDM-TA2s after Long observed how mixers used the MDM-4s.

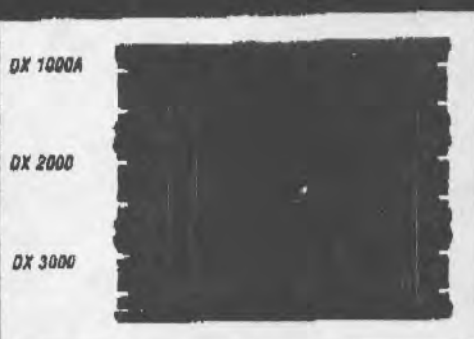
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*Program Power is a indication of Channeltron's undistorted power capability when amplifying

"They sat in one position when recording and another when listening to the final product," he says. The switch simulates the response at these two different listening positions.

THE PRESSURE RECORDING PROCESS

Long, along with Ron Wickersham, developed the Pressure Recording Process and the PRP microphone out of a need to make recordings that sounded like the original performance.

"Normal recording techniques just didn't capture what I could hear when I made the recordings," he says. "I realized that when the ratio of direct and reverberant sound seemed right, the sound was always duller than what I heard live. When Ron Wickersham and I were asked by Tam Henderson to make the first album for Reference Recordings, we began to discuss how microphones respond to direct and random incidence sound."

Long then proceeded to investigate microphones. What he found was that "the random incidence response of most microphones is rolled off compared to the response for direct sound. We realized that if we could cause a microphone to have the same spectral response for the direct and random incidence sound, we could adjust its position to achieve a desirable ratio of direct and reverberant sound without paying the penalty of dull sound."

He collaborated with Wickersham, his long-time friend, on this project. They figured they needed a pressure capsule and realized that just placing a mic down on the floor wasn't good enough. The result was the Pressure Recording Process (PRP), for which they were granted a patent.

Long auditioned some of his recordings that he made with his experimental mics at a Syn-Aud-Con class, hosted by Don and Carolyn Davis. After that, Ken Wahrenbrock made up PZM mics using electret capsules; eventually, Crown was licensed to produce them.

"Ron and I made four albums for Reference Recordings and another album for the Ambience label," Long says. "We did the recordings to see what could be accomplished, and to see why things didn't work the way we thought they should."

ELF

"Ron and I also collaborated on another interesting problem which resulted in a patent," Long says. "I had designed many subwoofer loudspeaker systems but I was never satisfied with the results. Together we came up with the Extended Low Frequency technology, which produces the most realistic bass I have ever heard."

"Because the ELF technology doesn't rely on wavelength-dependent, assisted-resonance ideas, it can be scaled for use in automobiles, personal stereos, TVs, key-

board instruments and even games. It's the most versatile way to produce bass that I know."

ELF allows the installation of a large diameter bass driver in a smaller cabinet than would normally be possible with conventional design. Paraphrasing Long's description of the ELF circuitry, it allows a bass driver to be driven with a signal which is exactly complementary to its response above and below resonance. It produces a rolled-off response above reso-

nance, and a response which is flat down to the lowest frequency limit that is chosen in the design.

CRM-100 MONITORS

Once Long had the ELF technology to give him the realistic bass that he was looking for, he had all of the pieces that he needed to make his premier monitor loudspeaker system, the CRM-100.

The 8-inch driver that is used had already been designed when he was work-

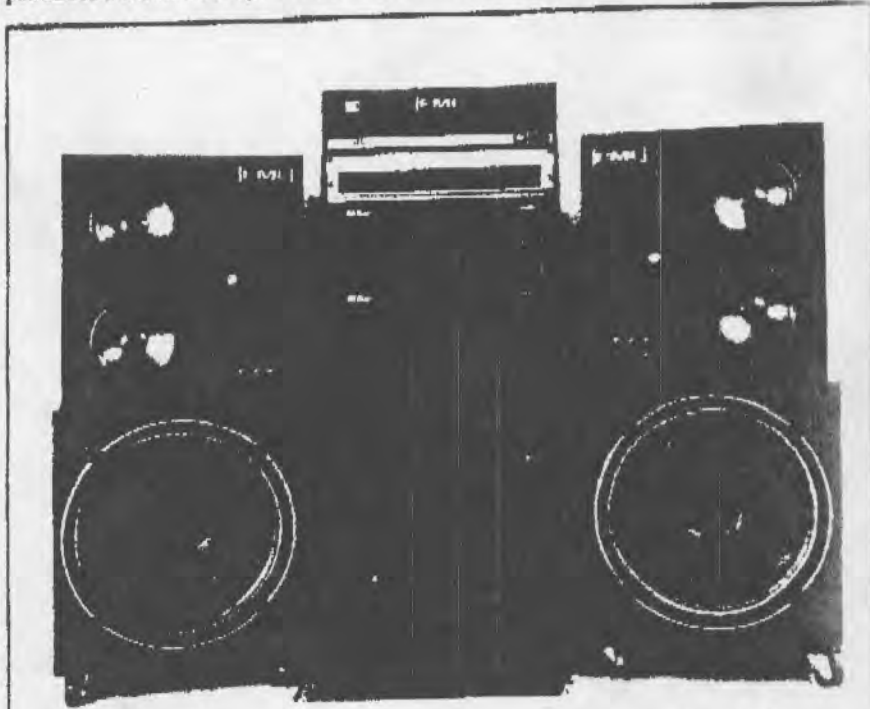


Photo by Allison Long

CRM-100 CUSTOM MONITOR SYSTEM

The CRM-100 custom monitoring system was designed by Ed Long for high level control room monitoring applications. It incorporates Long's Time Align and ELF technologies.

The basic system consists of two CRM-1TA Time Align mid/high range modules, two CRM-B18 ELF bass modules, the HLE2 ELF Electronics, three power amplifiers and interconnect cables. Another version designated as the CRM-100/SS is available for surround sound monitoring. Each system is calibrated to produce a flat acoustical output from 30Hz to 20kHz.

The CRM-1TA consists of a TD3/5 high frequency driver, two MD20/182 midrange drivers, and a passive time delay crossover network with protection circuitry that monitors the RMS heating current. It has a

separate fuse for each driver and these are mounted on a front plate with an overload protector. The black laminate-finished, internally braced MDF enclosure measures 19" x 20" x 9 3/4".

The CRM-B18 bass system uses an 18-inch driver in a 20" x 20" x 11 3/4" black laminate MDF enclosure, with an internal volume of only two cubic feet. It is designed to work with the HLE2 ELF Electronics, which incorporate the patented Extended Low Frequency technology. Additional CRM-B18 modules can be added to the system.

These monitors have been installed at Paradise Sound Recording, Index, WA (Chips Davis, designer); Limelite Video, Miami; ABC Post-Production Audio Sweetening I, New York, and a personal studio for musician Steve Miller (all three designed by Russ Berger, Russ Berger Design Group).

ing at CTS.

"For more than 1 1/2 years, I worked on the 8-inch driver and tried to get perfection. I wasn't satisfied at first with what I could do, so I worked to make it come off better. With the 8-inch driver, the sound is real and you can listen to it for long periods."

The high end section of the monitor system was yet another design that Long had already worked out years ago. His goal was to produce high frequencies at a high SPL, and with good off-axis response. The solution: a large diaphragm and a small orifice.

Long was so pleased with this system that he installed handpainted, hand-brushed aluminum nameplates with his initials, EML, on all of the system components.

Because Long looked up to the Ampex logo, as it symbolized to him a high level of quality, he honored that concept and paid tribute to Ampex's contributions to the audio industry with his own logo. The ELM logo uses the same lettering as Ampex's. These monitors have found homes in recording studios, broadcast facilities, and post-production rooms. (See the sidebar, "CRM-100 Custom Monitoring System.")

Russ Berger, of the Russ Berger Design Group, and a noted studio designer, says, "There is no 'perfect' monitor system, only appropriate ones. Long's MDM, TA and CRM series monitors not only cover a wide range of accurate audio monitoring needs, but are also some of the most pleasant-sounding monitor loudspeakers I have experienced."

Chips Davis, now with Frank Hubach Associates, concurs: "The CRM monitors have a clear low end, a smooth mid range, and no high end sizzle that a lot of monitors have."

Summing up his feelings about Ed Long's work, Berger says, "The audio world is a better place, and we've all benefitted both directly and indirectly, thanks to Ed's creative achievements." ■

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