" L-ACOUSTICS & LINE ARRAYS"

August 2001

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Contact: Mélanie Cerveaux
Phone # +33 160 12 75 49
Fax # +33 160 12 55 18
Email melanie.cerveaux@l-acoustics.com

"LINE ARRAYS AND L-ACOUSTICS"

INTERVIEW OF PAUL BAUMAN, TECHNICAL SUPPORT DIRECTOR
FOR LIVE! MAGAZINE

Line arrays seem to be an area loudspeaker manufacturers are keen to develop…

For me it's an obvious response to the success that V-DOSC has had in the industry and the bandwagon is getting quite full indeed. Still, V-DOSC remains the benchmark that others are compared to but from our perspective there's the danger that technically inferior line array systems will negatively impact the marketplace. It's one thing to innovate, another to copy and there is a big difference between a line source array and a line array. Caveat emptor definitely applies.

That said, the main advantages of line arrays are smaller systems that result in more cost effective transport, better audience sightlines, fast/predictable installation and, most importantly, better sound quality (provided it's done right, of course). For instance, a perfect line source provides well-defined control over vertical directivity that means that is possible to focus more energy on the audience and excite less room reverberation. This is a key benefit that allows you to push back the critical distance in a venue (the location in the room where the amount of reverberant energy is equal to the direct sound coming from the system). Combined with the distance attenuation advantages of cylindrical wavefront propagation (3 dB loss per doubling of distance versus 6 dB for spherical wavefronts), this means that more of the audience can enjoy a nearfield listening experience.

Subjectively, nearfield listening means that the loudspeakers seem much closer than they physically are and it's a very ''in your face'' listening experience. In addition, your attention tends to be drawn to the action onstage, not the loudspeaker arrays - this is a subtle but very real difference. These days, when I see a show on a conventional PA, apart from being distracted by frequency- and position-dependent comb filtering, I find myself listening to speaker clusters rather than watching the band and that's not what a concert should be all about. For the FOH engineer, V-DOSC provides a predictable, repeatable reference monitoring system that allows him (or her) to focus on the finer details of the mix while having confidence in the evenness of coverage and stereo imaging that the system provides, i.e., console moves will translate well throughout the venue. I like to think that the technology helps empower both the artist and the engineer to better communicate their message.

Nearfield extension also means that extreme sound pressure levels are not required close to the system in order to produce acceptable SPLs further back in the audience - this results in reduced potential for hearing loss for both audiences and engineers alike. Another benefit is the high degree of SPL rejection obtained outside the coverage pattern of the system. Nominally as high as 20 dB, this permits the installation of a V-DOSC array behind or above microphones with exceptionally high feedback immunity. Monitor engineers enjoy working with V-DOSC FOH systems since there is very little backwave on stage - even at lower frequencies. High SPL rejection outside of the defined coverage region also makes V-DOSC an excellent solution in situations where environmental noise control is an issue, for example, where outdoor venues are located close to residential areas. In some cases, local bylaws even stipulate that only V-DOSC can be used in certain venues.

I don't think this is a fad, there are real benefits if it's done properly. I've worked with many conventional PAs in the past and once you've tried V-DOSC you can't go back. There's simply no comparison and the benefits are real. Some people refute the idea of cylindrical waves - I say take out your sound level meter and do some measurements on a V-DOSC rig. Then use the analyzer between your ears and draw your own conclusions.

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L-ACOUSTICS is in the enviable position today of being the system of choice for a strong majority of FOH engineers. In some cases it's the FOH engineer's decision, sometimes it's production and in some cases it's even the artist who decides. The bottom line is that V-DOSC is specified on many technical riders and this is something that we at L-ACOUSTICS appreciate and value highly - I'm not trying to be arrogant here, I'm simply stating fact. For me this is a sacred trust - no advertising campaign can buy this kind of good will and from our standpoint this means that we at L-ACOUSTICS will go the extra distance to provide whatever technical support is necessary. The people making these decisions are basing their choice on the performance of the system, the service provided by the V-DOSC Network and the quality of the technicians installing and operating the system on a daily basis - not on an advertising campaign (in fact, there's never really ever been one for V-DOSC - we're more concerned with R&D and technical support). What V-DOSC has achieved in this industry is in many ways unprecedented. The system literally speaks for itself and most of its success has been due to word of mouth.

There is a lot of science behind V-DOSC, in fact we could say it was developed mathematically from first principles by two very competent physicists, Christian Heil, CEO of L-ACOUSTICS and Marcel Urban, Professor in Physics. Sometimes the most elegant answers come from people approaching a problem from an entirely different angle. Note: the theory behind V-DOSC and what we call WST will be presented at the upcoming AES convention in New York this September with our preprint entitled ''Wavefront Sculpture Technology''.

Can you briefly explain the basic concept?

In the early development stages, Christian Heil and Marcel Urban used the Fresnel approach from optics to help understand interference between multiple sound sources and to determine conditions for coherent coupling. That's the different approach to an old problem. Fresnel analysis does not provide precise numerical results but gives a semi-quantitative, intuitive understanding of interference phenomena. More precise results came later using numerical analysis techniques, but Fresnel analysis helped to predict the answers ahead of time and provide the basic design objectives.

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Basically, in order to create a working line source array, the challenge was to define when an assembly of discrete sources could be considered as equivalent to a continuous source. And to make a long story short, the Wavefront Sculpture Technology criteria for arrayability can be summarized as follows:

For a flat array:

- either the sum of the individual flat radiating areas covers more than 80% of the target radiating area (ARF > 80%, i.e., Active Radiating Factor)
- or the spacing between sound sources is less than ?/2 at the highest operating frequency
- and the deviation from a flat wavefront should be less than ?/4 at the highest operating frequency.

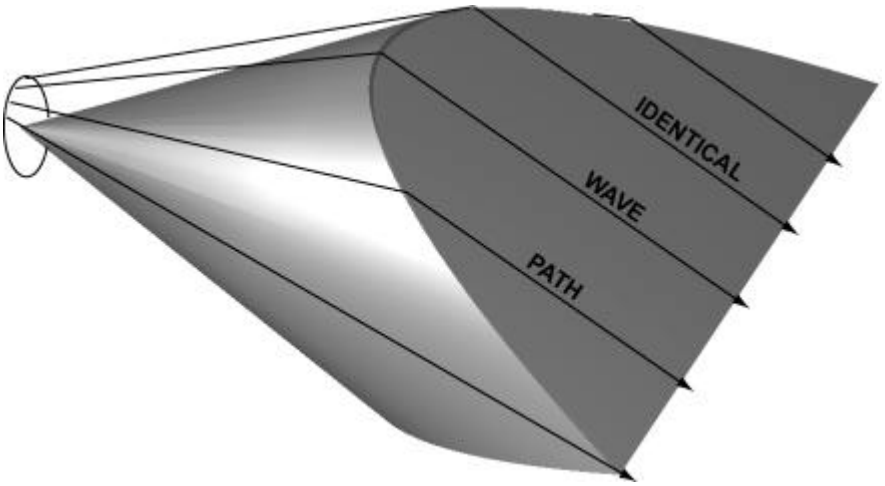
For a curved array, the same criteria as for the flat array, plus:

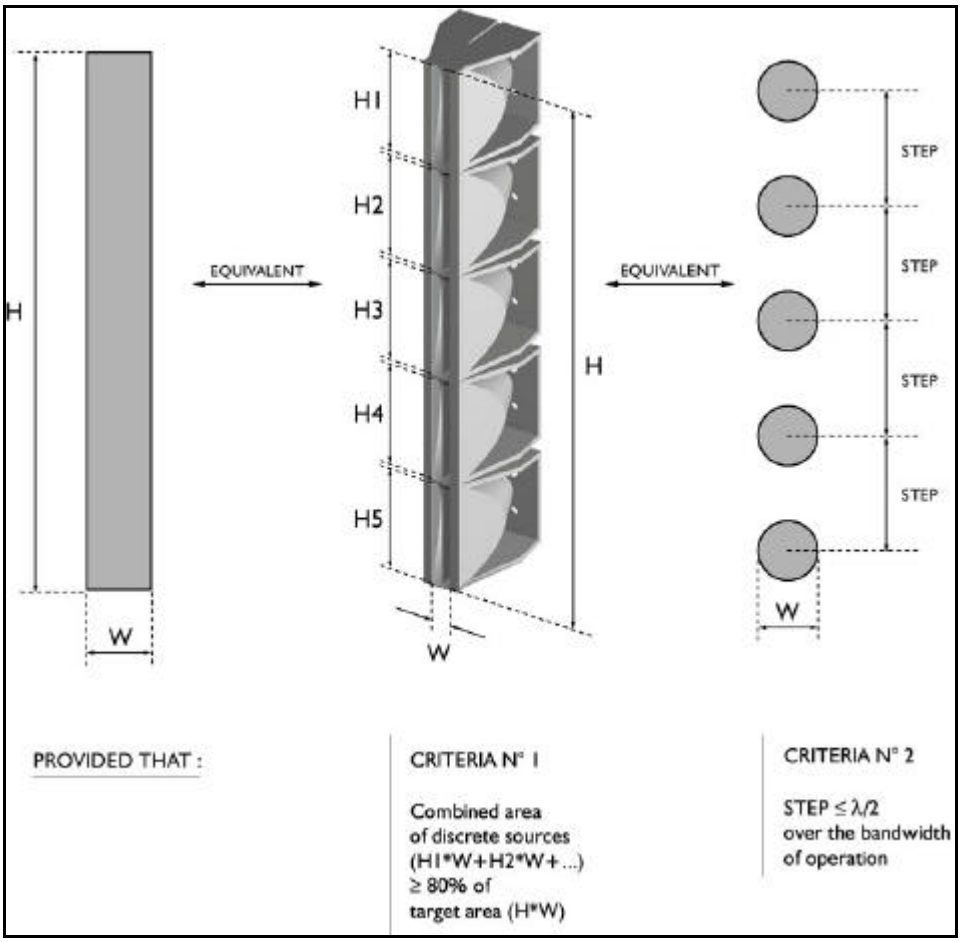
- enclosure tilt angles should vary in inverse proportion to the listener distance - this corresponds to equal spacing between enclosure impact zones on the audience listening level
- the vertical size of each enclosure and the relative tilt angles between adjacent enclosures should conform within certain limits (that are defined in the upcoming AES paper).

The most difficult bit is to achieve proper coupling at higher frequencies. It becomes impractical to locate sources close enough to each other to satisfy the half wavelength criterion (the spacing between acoustics centres becomes too great at higher frequencies) and conventional horns will always have too much wavefront curvature to satisfy the lambda/4 criterion (no matter how high the Q) and/or will not satisfy the 80% ARF rule.

This is why the DOSC waveguide was specifically developed - to generate a flat, isophasic wavefront at the exit of the device. For the frequency range of 1.3 - 16 kHz, the sound pressure of a circular piston (the output of a compression driver) is passed through the waveguide where all possible acoustic path lengths are identical in length. This produces a wave front that is flat and isophasic (constant phase) at the rectangular aperture of the opening. This geometric transformation from circular to rectangular

creates a wavefront that is sufficiently flat to satisfy the limits of acceptable curvature and experiments have shown that wavefront curvature is less than 4 mm at 16 kHz. When multiple DOSC waveguides are vertically arrayed, this allows for satisfaction of the 80% ARF criterion provided that the angle between adjacent enclosures is less than 5 degrees for the case of V-DOSC and 7.5 degrees for dV-DOSC. And no, there's not a lot of distortion generated in the process - this is an expansion device, not a compression or phase plug type of device. According to Christian Heil, once WST criteria were defined it was relatively straightforward to develop the DOSC waveguide since it is the only geometric shape that will perform this transformation. This is also why it could be patented internationally.





WST Criteria Illustrated. On top we see the central portion of the DOSC waveguide that geometrically sets all possible sound path lengths to be identical from the circular entrance to the rectangular exit of the device, thus producing a flat, isophasic source for the high frequency section. The bottom figure shows a stack of 5 such devices (including the outer housing) which produces a vertical, flat sound source satisfying WST criteria 1.

I understand that it's not an altogether new technology and that L-Acoustics kick-started the latest spurt in it's development in the mid-'90's, and that consequently V-DOSC has come to be seen by many as the current industry standard. Would you agree?

Yes I would agree with that and as I said, V-DOSC remains the benchmark that other systems are compared to. But there is a big difference between the V-DOSC of today (a true line source) and the column speakers of years gone by. V-DOSC was introduced

to the market in 1992 very carefully, step-by-step, with particular attention paid to the necessary technical support is required to properly use this kind of technology.

Throughout the course of numerous V-DOSC training sessions, I have had the pleasure of meeting many of the world's top sound engineers - system engineers and FOH engineers included. One of the highest compliments I can relate is when a veteran, seasoned road dog tells me that working on V-DOSC has made it new and fresh again. They enjoy the rational approach and predictable results allowed by the ARRAY 2000 software and the installation/focus techniques. A few have even gone so far as to say that they were considering retirement but were so keen on working with the system that they were reinspired - as they described it, they came to enjoy the sound design aspects more than the drudgery of just rigging PA on a day-to-day basis. This kind of comment is very gratifying - to feel that you have provided someone with a better tool. Work smarter, not harder is a good way to see it. At the end of the day, it's all about better sound and the people care about that.

How do other loudspeaker manufacturer's systems differ/compare?

Now that's a loaded question if ever. Most manufacturers seem very preoccupied with comparing their system to V-DOSC and I don't think I'll get into a counter-defense discussion here. Nonetheless, with each manufacturer's release we evaluate the competing system in terms of the WST criteria described above to see how close they come to satisfying these fundamental technical requirements. Some get a few aspects right, others seem to miss the whole point. The real key is proper HF coupling and this is where V-DOSC is on the leading edge. Some approaches can work up to a certain high frequency limit but do not have coherent coupling out to 16 kHz. Wavefront curvature less than 5 mm is a very strict criteria that must be met. In addition, there is a tradeoff between the size of individual loudspeaker enclosures and the maximum allowable angle between these elements. For V-DOSC, it's 5 degrees and for dV-DOSC it's 7.5 degrees. If someone tells you they can open further, question it.

I strongly feel that another important consideration is the configuration of transducers within individual enclosures. For V-DOSC and dV-DOSC it's symmetrical with respect to the plane of propagation of the wavefront, i.e., the plane bisecting the horizontal coverage angle. High frequency transducers are located in the middle, mid frequency transducers are on both sides of the high section, and low frequency transducers are laterally positioned on both ends. Such a configuration is described as having coplanar symmetry and this is the cylindrical domain equivalent of a coaxial source (another sound reinforcement approach that was pioneered by L-ACOUSTICS with the MTD line of coaxial enclosures intended for distributed sound design). Essentially, coplanar symmetry allows for homogeneous coverage of the sound field at any listening angle over the V-DOSC array's 90° horizontal coverage window (for dV-DOSC it's 120 degrees). Coplanar symmetry helps eliminating off-axis acoustic cancellations at crossover frequencies and, psychoacoustically, is largely responsible for the exceptional stereo imaging properties that are characteristic of V-DOSC. In my opinion, any system that does not have coplanar symmetry is going to have problems horizontally. Apart from this and the inconvenience of having to fly mirror image L/R arrays, lack of coplanar symmetry can lead to practical rigging complications since the centre of gravity is not centred on the enclosure.

So based on the previous 2 arguments, we've eliminated quite a few systems as even close to becoming a serious contender.

What does the V-DOSC serie consist of? What are its main features?

V-DOSC is a loudspeaker enclosure. The SB218 subwoofer, dV-DOSC downfill and/or ARCS infill/sidefill/offstage fill, and 115FM stage monitor are the loudspeaker complement of our touring sound rig. The V-DOSC series also includes touring amplifier racks with L-ACOUSTICS LA 48 amplifiers (OEM version Lab Gruppen 4000) and L-ACOUSTICS PADO_4 amplifier rack panels. All loudspeaker and signal distribution cabling is part of the V-DOSC standard, as are digital processors (XTA DP224, DP226 or BSS 355, 366) and OEM factory presets. Last, but certainly not least, is the Certified V-DOSC Engineer (CVE) or Qualified V-DOSC Technician (QVT) who

installs and operates the system . I would also include V-DOSC training and instruction in the use of ARRAY 2000 software as part of the system.

For me a very important aspect of the V-DOSC system is a trained, skilled operator. In my experience, if careful audience geometry measurements are taken, a detailed coverage prediction is done in ARRAY 2000 followed by correct installation and focus then the system is pretty much plug and play provided the correct OEM preset is selected. I rarely have to do much eq on the system provided it's installed properly. Ultimately, this provides a rational procedure that although might seem complex at first, is quite simple once you're familiar with it. At the end of the day, it saves time and produces better results.

When, how and why was it first developed?

I think Dr Christian Heil's early motivation came from becoming friends with the Malki brothers of Potar Hurlant - a sound company located close to L-ACOUSTICS and a V-DOSC Network Partner since the beginning. He began attending some of their shows and started considering the problems of arraying conventional horn-loaded loudspeakers. Realizing that this simply could not work, he started trying to find a better way to achieve coupling of discrete sources and began discussions with Pr Marcel Urban, a colleague at the National Scientific Research Centre (CNRS). Ultimately, these discussions led to the definition of WST and, in many ways, it all started as an academic exercise among two physicists.

V-DOSC was released in 1992 and is the first exact embodiment of the principles of Wavefront Sculpture Technology. V-DOSC stands for "Diffuseur d'Onde Sonore Cylindrique" – in English this means Cylindrical Sound Wave Generator. The "V" in V-DOSC refers to the V-shaped acoustic lens configuration employed for the mid and high frequency sections. V-DOSC was designed as a system consisting of identical, vertically-arrayable elements where the individual transducers are physically arranged within each enclosure so as to meet WST criteria, frequency band by frequency band, when the enclosures are arrayed together.

What recent tours/events has it been / will it be used on? (very good things were heard about it from people involved with Radiohead, for example!)

As we speak there is Neil Young and Crazy Horse, Mark Knopfler, Radiohead, Roxy Music, Aerosmith, Lynyrd Skynrd/Deep Purple/Ted Nugent, Bob Dylan, Tom Petty/Jackson Browne and Robbie Williams out on the system - just to name a few. I was personally involved in the recent Radiohead Oxford festival and found the results at I to be stunning at times. When you put a talented FOH engineer like Jim Warren and have a top notch CVE like Florent Bernard on the system, the results can be magic, especially with a band like Radiohead. Other high profile tours in the recent past have included: Ricky Martin, Matchbox 20, Marilyn Manson, The Offspring, Lou Reed, Macy Gray, The Cure, and Widespread Panic, CSNY. High profile events would have to include things like Rock in Rio 2001, Pavarotti and Friends, and repeated installations for the Superbowl half-time show, Grammy Awards, and Academy Awards in the USA (courtesy of ATK in the US).

Any further developments?

Always - you can't rest on your laurels in this industry. L-ACOUSTICS tries to introduce a rational, strategic line of products. We're mainly interested in introducing sound design tools that will compliment and integrate well with the existing product line, have a long product lifespan and serve as a good long term investment for our customers. We're not like some manufacturers who develop products as if throwing spaghetti at the wall to see what sticks and have a large engineering team to keep busy.

We're a small but focussed and dedicated group working on strategic developments. Currently, I'm very excited about the introduction of the dV-SUB. When dV-DOSC came out 1.5 years ago it really took the industry by surprise and to this day, there is nothing else like it on the market. With dV-SUB we have a perfect complement to dV-DOSC and it's as if we've introduced an entirely new system by virtue of its release.

Other developments include upcoming preset library releases and we also intend to extend DSP support to the Yamaha DME32, BSS Soundweb and Mediamatrix in the near future in order to better address the needs of the permanent install market.

I'm also excited about the introduction of CATT and EASE modelling capability for our WST-based products. It's been a long battle convincing people of the need for proprietary modelling for these types of line source arrays but we will soon have the capability to better address this. Last off, I just had a final listening test of the analog controller for the MTD108a today. This diminuesque coax should prove very useful as a fill enclosure or compact stage monitor!

Finally, a bit about yourself and your role at L-ACOUSTICS. What is your title? Can you give a brief career history?

I have been with L-ACOUSTICS since 1998 and am currently Director of Technical Support. Given my background in touring sound, I focus on this area while Stephane Gramondo handles fixed installation - he's the CATT and EASE expert. One of my primary tasks is to develop and conduct V-DOSC training seminars worldwide (apart from North America where my counterpart Bernie Broderick of Cox Audio Engineering handles things). In conjunction with this, I'm actively involved in all ongoing developments with V-DOSC - whether it's system packaging, presets, manual updates, you name it. In 3 years, I can say that I've trained approximately 350 people on V-DOSC - that's quite a few sessions since we try to limit class size to 8-12 people max. I also particpate in corporate management of L-ACOUSTICS along with V-DOSC Network decisions. Other things I take care of include: product manuals, spec sheets, technical bulletins and final development of digital presets for all products.

Christian Heil is in charge of R&D (as well as L-ACOUSTICS, of course) and I work closely with him in the area of product development - things such as identifying products to be developed (or improved), defining preliminary specifications, prototype evaluation and final product tuning. I do technical seminars at trade shows on WST in

support of new distributor activities. Lastly, I get involved in sound design / system engineering for fixed installations and special events in support of our distributor and V-DOSC partner activities. Some projects I've been involved with include: Les Eurockeenes de Belfort (France – 1999 & 2001), Rock in Rio (Brasil – 2001), Dream Concert in Seoul (Korea – 1999, 2000), Aerosmith Wembley (UK – 1999), Radiohead Oxford (UK – 2001), and Mamma Mia installations in London, UK and Toronto, Canda. It's essential to get out there in the field to keep your hand in, find out what works/doesn't, what's needed etc.

In terms of background, I graduated with a Master of Science in Physics from the University of Waterloo, Canada in 1985. I had the pleasure of having audio gurus John Vanderkooy and Stanley Lipshitz as supervisors and did my thesis on digital signal processing techniques for loudspeaker measurement. As a research engineer at McMaster University, I worked in the field of mm-wave antenna technology (line arrays - surprise!) and integrated circuit design, leading to a Masters in Electrical Engineering. Following this, I joined Chalmers Institute of Technology in Sweden as a guest researcher, working in the field of structural intensity measurements with interests in the areas of room acoustics modeling and auralization. That's how I got into CATT and got to know people like Mendel Kleiner and Bengt-Inge Dahlenback. Along the way, I've also held positions as Chief Engineer for a Canadian loudspeaker manufacturer and Director of Research & Development for the touring sound company Maryland Sound International, based in Baltimore, USA.

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