

Pro-line Radia Professional Speakers from Bohlender-Graebener ... An intelligent solution for sound in the new millennium.

The system you have been waiting for

In audio the criteria used to describe speech reproduction are even more demanding than for music quality. Yet the quality and fidelity of sound in hi-fi systems designed for music get more attention than sound reinforcement systems intended specifically for speech. It is natural to ask if a loudspeaker can be designed that can break through the current physical limitations and overall cost associated with delivering the desired sound quality, intelligibility, coverage and localization. In addition, one would like this system to be visually appealing and to achieve architectural and visual harmony as part of a complete installation.

Such a loudspeaker exists! It is the RP-line planar magnetic system from Bohlender-Graebener. Below you will find an explanation on why and how the Pro-line could be your favorite and possibly the only choice for your next project.

Planar transducers, what are they?

Planar magnetic transducers, also called “ribbons”, are a part of the planar loudspeaker family. Planar loudspeakers have been known and prized for their exceptional quality sound since the 1950s, when the British company Quad developed ESL, a now famous electrostatic speaker. In this design a thin metallized diaphragm is driven by electric field forces from surrounding flat perforated electrodes. Another well known type of planar design is a ribbon transducer. It incorporates a strip of corrugated aluminum foil placed between two magnet poles and a transformer, coupling the low impedance foil strip to a power amplifier. This is essentially an electrodynamic device.

Despite their excellent sound qualities, these types of transducers have limited applications, mostly in esoteric high-end systems. The reasons for this can be attributed to high cost, dynamic range limitations, complexity of manufacture, labor intensive assembling technology and relatively low reliability under stressful conditions. Is it possible for planar systems to overcome these limitations?

The answer can be found in a third type of speaker – the planar magnetic transducer that Bohlender-Graebener has developed and named the “*Pro-line system*”. The timing is perfect.

The unprecedented development of audio electronics and new audio formats and media has created the need for a better loudspeaker. Current loudspeaker manufacturers are still using compression drivers loaded with a horn and crossed over in the most subjectively sensitive frequency band to a large heavy cone woofer - a 1930-1940s technology that has been used as a compromise due to the absence of high power amplifiers. The price of this compromise has become obvious – it is sound that is far from being high fidelity. Today, many “intelligent” applications have been emerging, where quality, fidelity and intelligibility is the goal. Is it necessary to be constrained by the old compromised technology? Not at all, because the RP-line planar magnetic technology is now available.

A planar magnetic transducer uses a conductive pattern (aluminum foil lines) laminated or etched on a film diaphragm rather than a mere strip of aluminum foil and transformer in pure ribbon device. This allows for higher impedance, eliminates the need for a costly audio transformer and produces greatly increased reliability. Over the years numerous companies pursuing a dream for better sound have developed planar magnetic speakers. Strathearne, Magnepan, Apogee, Carver, Infinity, Eminent Technology, Philips, Foster, ESS (Heil air motion transformer), Newform, all of them were, and some still are, manufacturing high performance planar magnetic loudspeakers in small quantities for the consumer market. However none of these companies has the goal or ability to extend planar technology into the professional field, where high fidelity sound has been long awaited. High cost, performance that is not adequate for pro market applications and reliability are among the reasons limiting the use of these devices.

Things are changing. With the 24bit/96kHz A/D conversion format becoming a standard, and with complete Dolby Digital home theater systems, plasma and HDTV television, coupled with a growing consumer awareness of good natural sound, speech intelligibility and a pleasant listening experience, there is a need for a loudspeaker capable of high quality sound reproduction. Radia Professional Speakers was founded with the mission of bringing planar technology to the professional market, thereby creating new opportunities for customers seeking better high quality solutions for the growing demands of the professional sound industry. In the process of developing the Pro-line loudspeaker Bohlender Graebener Corporation (BG Corp) of Nevada. BG has been known as a pioneer in research and manufacturing of line source planar magnetic transducers. The extensive experience and sophisticated manufacturing facility allowed the successful completion of this undertaking. The result was a launch of Pro-line loudspeakers.

Construction and principles of operation

The differences and benefits

A Pro-line transducer is a planar magnetic device that has a symmetrical magnetic system to drive an extremely light Teonex diaphragm having laminated aluminum conductors (see Fig. 1).

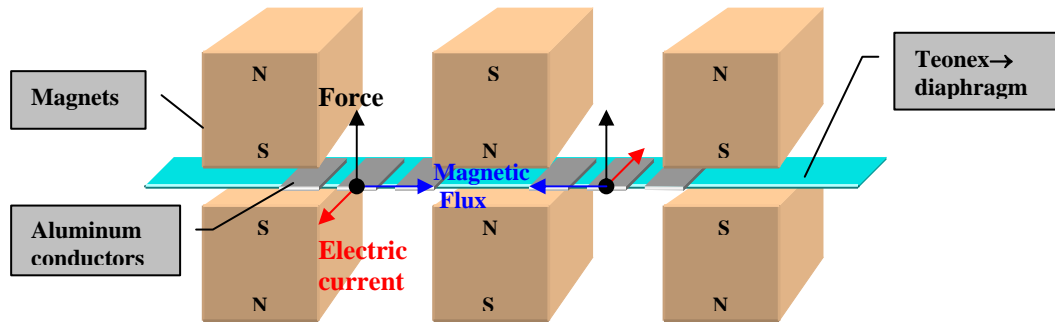


Fig 1. Pro-line transducer cross section

The symmetry of magnets, positioned from both sides of the diaphragm, provides even magnetic field distribution along the direction of the diaphragm displacement. The actual amplitude of vibration is very small and in presence of a constant magnetic field the result is very low harmonic and intermodulation distortion.

What new technology gave Radia Professional Speakers the capability to create a reliable professional product? How does the Pro-line differ from previous generations of planar loudspeakers?

First of all, a breakthrough has come from implementing the use of a new advanced polymer film, introduced by Dupont as Teonex. Most planar drivers of older designs used Mylar film, a polyester that does not handle high temperatures well beyond 80°-90°C. Under high power input the diaphragm tension drops due to the expansion of the Mylar and the film becomes rippled. This leads to distortion and eventually to delamination of the conductors. Teonex diaphragms tolerate temperatures up to 130°C without getting soft and rippled. Although Teonex is a more expensive material than Mylar, it's stronger and has lower density allowing for better reliability, higher sensitivity and greater power handling.

The use of special high temperature adhesives that bond conductors to the diaphragm provides not only increased power handling but also better damping which is critical for planar drivers.

It is noteworthy that Pro-line drivers have very sturdy and dimensionally stable construction. Each Pro 1.9, for instance, has 150 bars of 10x10x75 mm magnets that are securely bonded to two identical heavy gage steel shells. The curved metal design of the shells provides excellent rigidity, so when the diaphragm is precisely stretched and the shells are riveted together, the whole assembly represents an extremely solid unit capable of withstanding mechanical stress without affecting performance. Additional strength and optimal acoustic loading is created by special wave-guide elements riveted over the frontal surface.

Any cone woofer or dome tweeter moving system (including compression drivers) mechanically represents a shell that is excited by a force through a voice coil along the singular circle line at its edge (the apex of the cone and the perimeter of the dome). As taught in mechanics, this is the most “favorable” condition for inducing resonance behavior in the shell, plus it is not optimally terminated as in the case of a conventional driver. As a result, most cones are operating in the frequency range that produces break-up resonance, creating linear and non-linear distortion. There are also many other sources distorting the original signal in a conventional transducer such as motor system and suspension non-linearity, air compression and wave front distortion in horns and so on.

None of these drawbacks are inherent for Pro-line drivers. First of all, the Pro-line diaphragm is directly and uniformly driven. There is no voice coil attached to the edge. An electromagnetic force acts on the aluminum conductors and is evenly distributed over the entire diaphragm surface. This eliminates the tendency to generate distributed resonance vibrations. Secondly, Pro-line drivers do not have additional glue joints and parts. Nothing stays on the path of transforming electrical energy into sound, just a light tightened membrane, which is not the case for a conventional driver.

Pro-line drivers are also phase coherent over their entire operational band while cones and domes have an inherent phase "smear" due to their depth (or profile).

Another important aspect in performance is the difference in the mass of the moving system. The thin diaphragm of a Pro-line driver is ten times lighter than any compression driver diaphragm and even hundreds of times lighter than a woofer cone. This allows for an instantaneous response to the arriving signal as well as to the smallest changes in that signal. The low mass of a Pro-line moving system also allows for rapid decay after the impulse. All this results in superior transparency and low-level resolution not available in a conventional transducer.

Electrical impedance and crossover considerations

The topology of Pro-line transducer conductors and their disposition in the magnetic gap results in negligible inductance (less than in a cable) and the virtual absence of a resonance peak in the input impedance. Therefore Pro-line represents an easy resistive load for an amplifier, allowing it to perform effortlessly (see Fig.2)

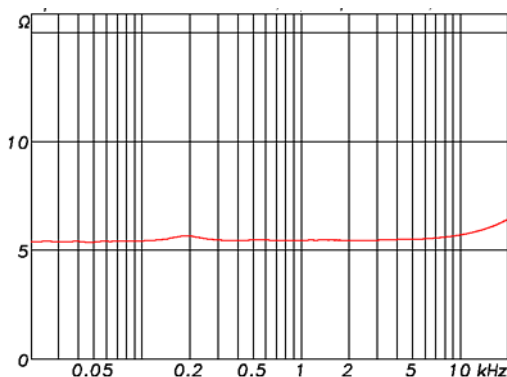


Fig.2. Pro 1.9 impedance

The same applies for a crossover. When a passive high pass crossover is used in a Pro-line/subwoofer configuration or for additional protection in high power systems, it will work according to its theoretical design prediction.

The absence of reactive electrical characteristics and the flat diaphragm provides unparalleled coherency of the Pro-line transfer function.

Another important advantage of the Pro-line system is the absence of a crossover in the very sensitive, for the human ear at least, midrange band (1-2 kHz). A crossover in this region, used in conventional loudspeakers, creates a phase shift and therefore such a system suffers from dispersion irregularities due to both crossover and physical transition from a cone woofer to a tweeter. Pro-line transducers do not have a crossover. As a result, this loudspeaker possesses excellent transient characteristics (step response); smooth phase and virtually zero group delay (see Fig.3). The phase does not deviate more than $\pm 35^\circ$ in the operational band. Group delay has a slight bump at 150Hz due to a natural high pass enclosure roll-off, being flat from 250 Hz and above. Step response data show the coherency and equal time arrival of all signal spectral components being reproduced through the Pro 1.9. In a way, the Pro-line is the ideal loudspeaker that delivers wideband reproduction covering the entire human voice spectrum with true minimum phase characteristics, superior coherency, fidelity and total resolution and transparency.

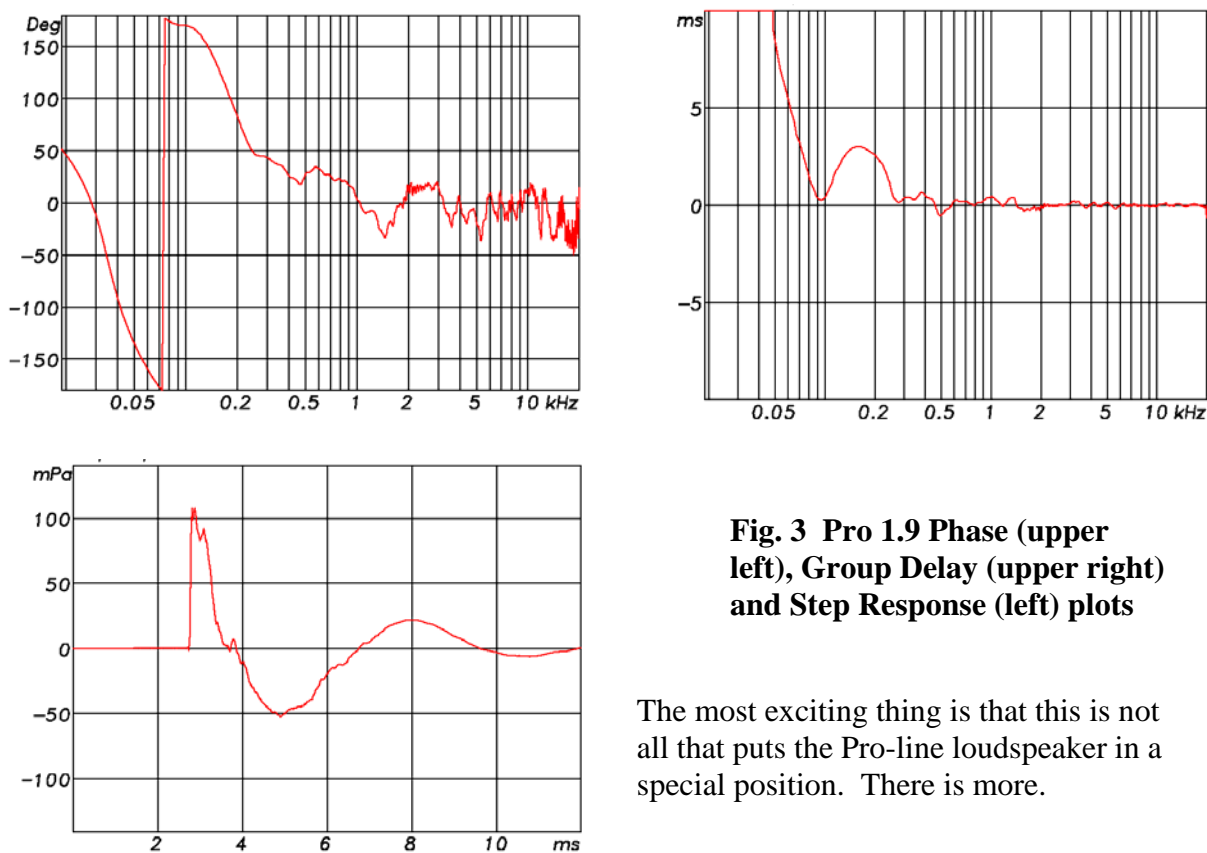


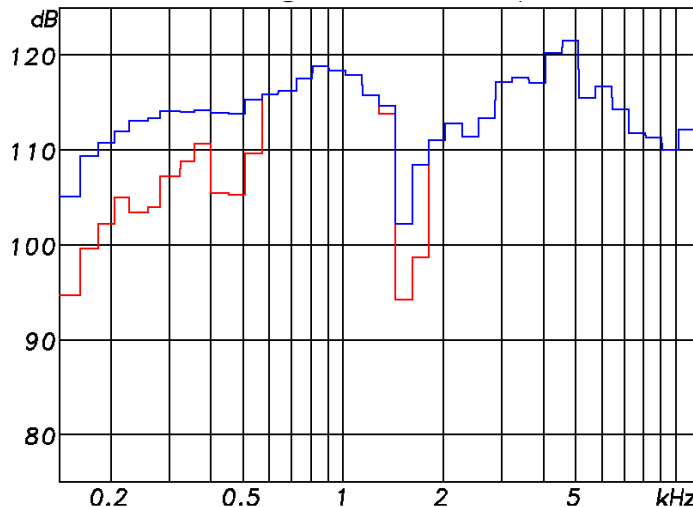
Fig. 3 Pro 1.9 Phase (upper left), Group Delay (upper right) and Step Response (left) plots

The most exciting thing is that this is not all that puts the Pro-line loudspeaker in a special position. There is more.

Power Handling and Maximum SPL

The new Teonex diaphragm, improved laminating technology, and a large area of aluminum conductors has allowed for a significant increase of Pro-line systems power handling over previous designs. Fig.4 shows an elaborate test made by Bohlender-Graebener to confirm the above. The measurements were performed at 1m. The Pro 1.9

is capable of delivering 115dB at 3% THD (red curve) over most of its effective frequency range. The max SPL curve at 10% THD (blue) does not go higher, because the amplifier used for testing had an 800W power limit.



**Fig4. Pro1.9 max SPL,
@ 3% THD (red) and
10% THD (blue) , max
power 800W.**

Longevity, consistency, reliability and environmental factors

A conventional loudspeaker driver is a complex electromechanical device. The complexity is doubled by the fact that this device has two stages of energy conversion; electro-mechanical and mechano-acoustical. The issue of longevity and consistency of performance over time and from batch to batch is a constant concern. On the electrical side there are crossover components, magnets, steel parts, glue joints, wires etc. On the mechanical side there is a whole spectrum of parts and factors affecting performance: cone, surround, dust cap, spider, and multiple glue joints. The characteristics and integrity of a conventional driver with these complex combinations of variables result in performance stability issues. Pro-line drivers do not have paper, fabric or rubber parts. The powder coated steel plates and magnets, Teonex film and aluminum are very stable to environmental hazards, do not absorb moisture and do not change properties over time. There are many fewer parts and variable parameters in Pro –line systems when compared to a conventional loudspeaker. This fact provides for better production consistency, stability over time and reliability for Radia Professional Speaker products.

Line source radiation qualities

The most unique and useful acoustical characteristic of a Pro-line system is based on its wave front form and dispersion pattern. Due to continuous and extended dimensions of a vibrating element, a line source radiates sound in the form of a cylindrical wave, while a conventional loudspeaker approximating a point source device has a spherical wave front (see Fig5.).

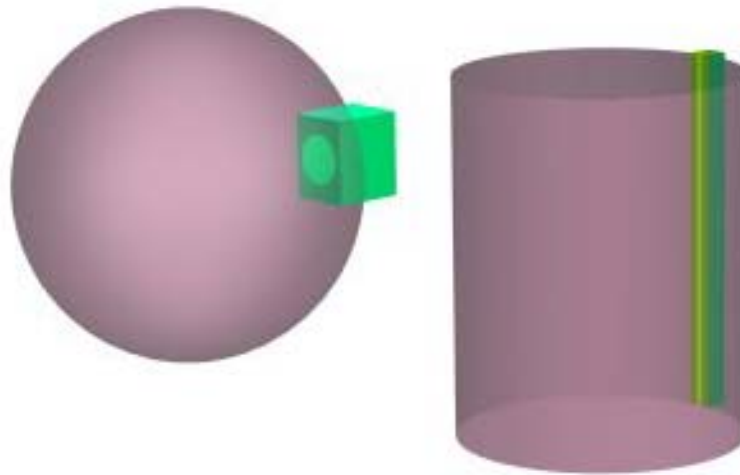


Fig.5 Wave fronts of conventional and Pro-line loudspeaker

Why is this distinction so important? Because a Pro-line system exhibits a very unique and useful feature – **the rate of Pro-line’s SPL reduction with increase of distance is one half that of a conventional system.**

This SPL/distance relationship can be simply understood by considering the energy conservancy law. Let’s assume that the radiating energy remains constant for a given space sector regardless of distance. This is true if we neglect dissipation losses in the air. With the increase of distance, sound energy spreads over a larger area on the front surface of this sector. Total energy remains the same, but sound intensity (energy passing through a unit of surface area) decreases. Since $I = W/S$, where I – sound intensity, W – sound energy, S – surface area, we can see that sound intensity decreases linearly with the increase of surface area.

In a spherical sound wave the surface area of a space sector $S_s \sim r^2$, where r is a distance from the center of a sphere. Since $I \sim 1/S_s \sim 1/r^2$ and $I \sim p^2$, then sound pressure for a spherical wave $p \sim 1/r$. Now we can understand the physics lying behind the “inverse square law”. That is – **sound intensity in a spherical wave is inversely proportionate to the square of the distance from the source. In terms of sound pressure it means that doubling of distance leads to sound pressure decrease by 2 or - 6dB in level.**

Now let’s consider this relationship for a cylindrical wave.

In a cylindrical sound wave the surface area of a space sector $S_c \sim r$. Since $I \sim 1/S_c \sim 1/r$ and $I \sim p^2$, then sound pressure for a cylindrical wave $p \sim 1/\sqrt{r}$. It is clear now, why **in a cylindrical wave with the doubling of the distance sound pressure decreases by only $\sqrt{2}$ or -3 dB in level.**

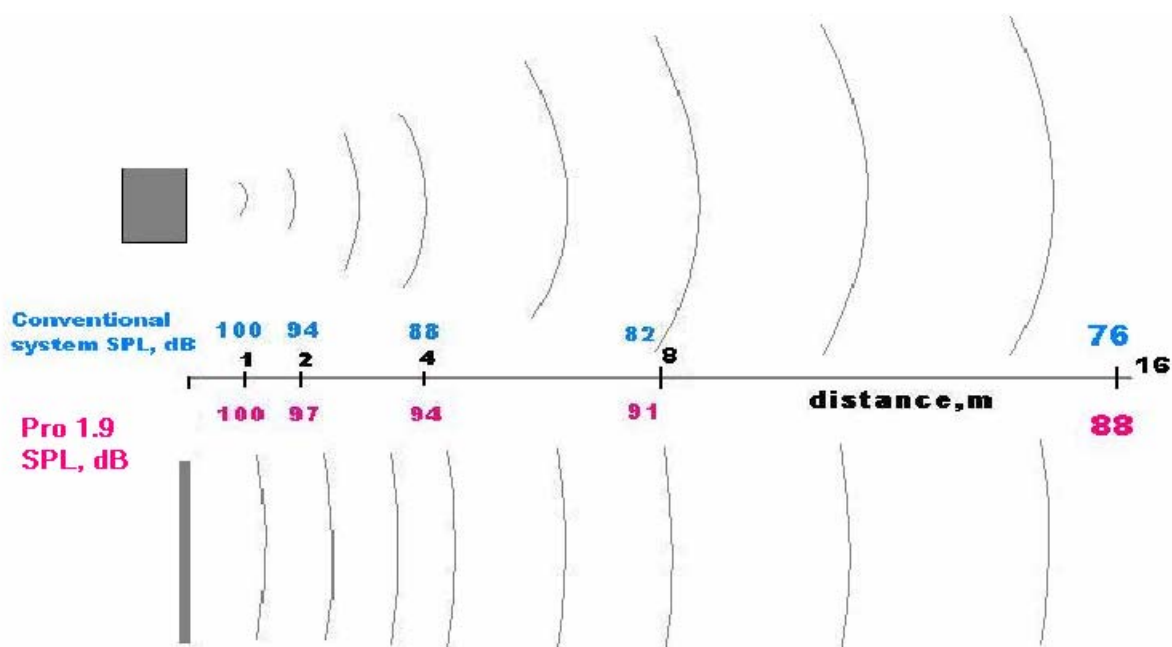


Fig 6. SPL reduction rate

This is "key" for understanding the principles of line source operation (see Fig6.).

As always in acoustics, we recognize that the above holds true for certain conditions. For any loudspeaker the inverse square law is valid in far field. In the case of a conventional single loudspeaker this means distances usually beyond 1-2m. Thus, one almost always (exception would be a near field monitoring) listens to a conventional system in its far field.

As for a Pro-line system, we can accept a cylindrical wave approximation only at distances before the far field condition is met, after that a line source is not a line source anymore. In the far field when the distance is large a RP-line behaves in the same manner as a point source. Let us determine these distances and hence the improved coverage distance we can expect; i.e. the -3 dB SPL reduction rate.

The far field condition, also known as Fraunhofer's approximation, for a radiator is as follows: $ka''/r \leftrightarrow 1$, where $k = \omega/c = 2\pi/\lambda$ – wave number, λ - is a wavelength and a – is a radius or, in case of a line, half of its length. Regrouping members and assuming $a = L/2$, where L is a line length, yields: $r \approx 1.57L''/\lambda$. This is the far field condition for a line source and $1.57L''/\lambda$ is the coverage distance where we can safely use the -3 dB reduction rate.

Let's take the Radia Professional Speakers Pro 1.9. Its length $L=1.9$ m. What would be Pro 1.9's enhanced coverage distance at a frequency 1000 Hz? $1.57 * (1.9)''/0.34 = 16.7$ m!

For 5000 Hz the coverage distance will be 5 times farther or 83.5m.

For 10000 Hz we have an extraordinary 167m!

What does it mean? It means that **the Pro-line will provide more effective radiation energy over a much greater distance.** This is a very important point in understanding Pro-line operation. Usually, when choosing a system for a project, one would consider sensitivity and power rating in order to project coverage distance and required SPL levels. This is true for conventional systems. When you consider Pro-line you have to keep in mind its unique properties, **the – 3dB SPL reduction rate.**

Consider the situation graphically displayed in Fig. 5 and quantitatively shown in Fig. 6. The real specifications would be as follows: Pro-line sensitivity 90dB/1W/1m, conventional PA system sensitivity 96 dB/1W/1m. Both systems produce 100dB at 1m. Therefore, the Pro-line amplifier output is 10W and the other system's amplifier output is 2.5W. Is this situation satisfactory? It is for Pro-line, because 88dB SPL at 16m (52 ft.) is more than enough for speech and music reproduction in most venues with a reasonable background noise level. It may not be satisfactory using the other system having only 76dB SPL. Let's say we want the other system to produce the same 88dB SPL at 16m. In order to increase SPL by 12 dB, we would need to increase its amplifier output by 16 times, from 2.5W to 40W.

Now, is this situation satisfactory? It is still doubtful. It is acceptable at the far end of the coverage area, but for people 2m from the source they would experience 106 dB SPL, which is definitely fatiguing. This is not the same 94dB as with Pro-line. Remember, the other system is drawing 4 times more power than the Pro-line loudspeaker. In many cases designers would start considering installing another overhead cluster to cover distant areas without overpowering the listener at the front.

As we see, **Pro-line loudspeakers allow for much more consistent coverage of the listening space from front to back. Also the Pro-line significantly reduces listener's fatigue common with conventional audio systems due to both excessive volume levels in the vicinity of the loudspeakers and an insufficient level of direct sound farther back in the listening or coverage area.**

There is more! At greater distances, we must consider room acoustic parameters. An early/late arrival energy ratio (C50, C80 parameters) is directly connected with subjective perception of clarity and intelligibility. The further we are located from the source, the less direct sound energy is available due to the increasing influence of reflections and reverberation. On the other hand, the level of high frequency components in reflected and reverberant sound is significantly reduced. Additionally, propagation air absorption may be noticeable at very high frequencies as well. All this leads to distorted balance, poor clarity and intelligibility, so commonly experienced with conventional systems at large distances. The fact that the near field zone ($1.57L/\lambda$) of Pro-line systems is extended with frequency, compensates for high frequency attenuation with distance. This is another feature allowing Pro-line loudspeakers to deliver high quality sound at very long distances. Subjectively it manifests itself as a virtual reduction of distance between listener and the system. It seems as if the Pro-line loudspeaker is much closer than it is in reality.

Another vivid illustration of SPL/distance reduction rate comparison between point source (conventional speakers) and line source radiators (Pro-line in near field) is shown in Fig.7.

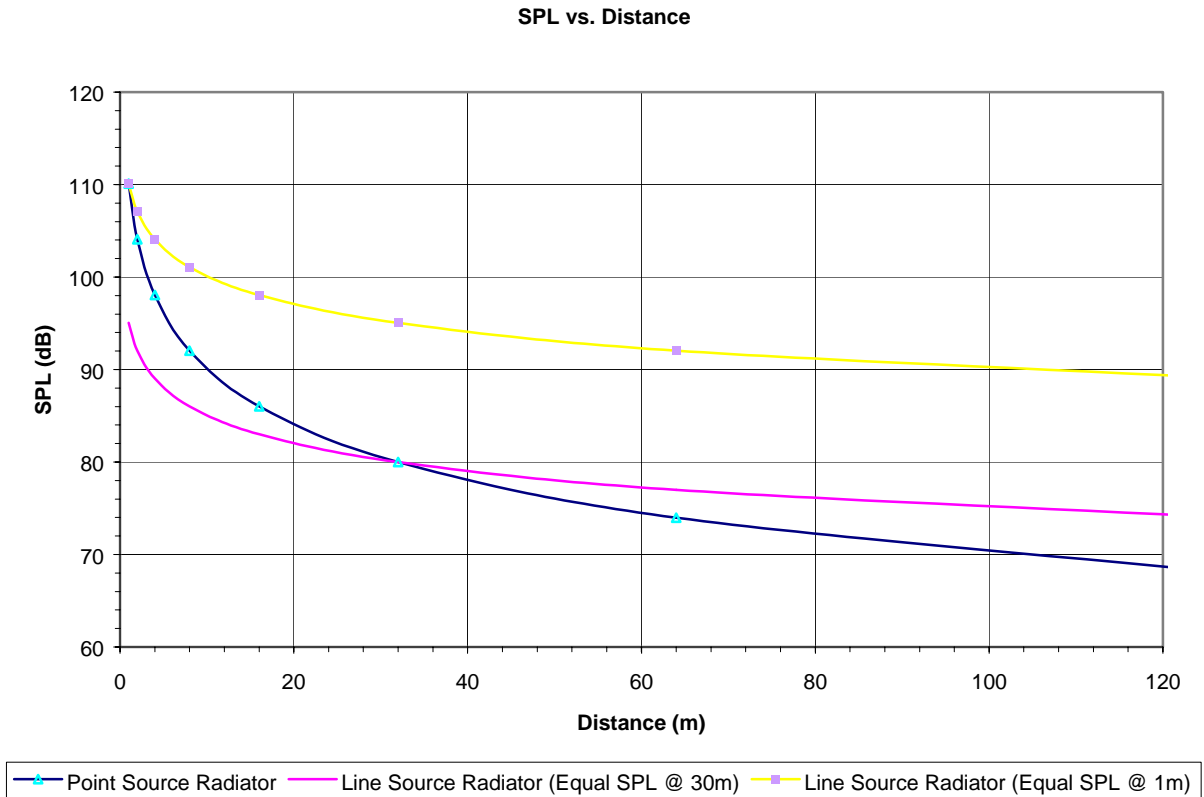
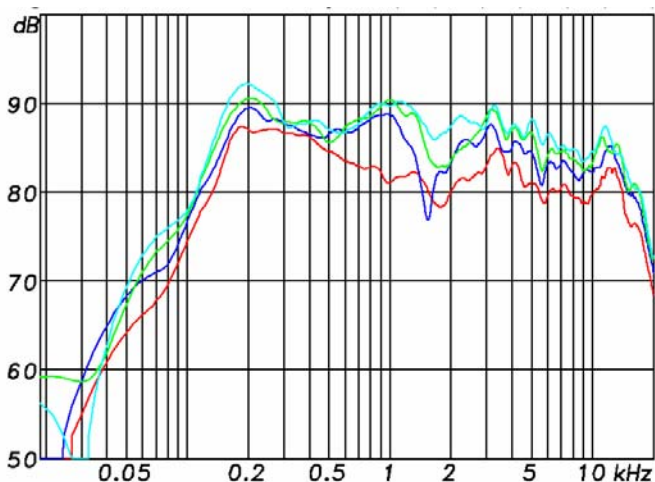


Fig.7 Point source vs. line source SPL reduction rate

Here we can observe that in order to have the same 80 dB SPL at 30m (98.5 ft.), a line source radiator should produce 95dB at 1m, while a point source radiator would be asked to produce a whopping 110dB! At 64m a line source will have 77dB, while a point source would have only 74dB. If both radiators have the same 110 dB SPL at 1m, then at 30m the line source will produce 95dB, while the point source only 80dB.



These Pro-line characteristics can be clearly proven by real measurements. Fig.8 demonstrates this phenomenon. A Pro 1.9 was measured at 1m, 2m, 3m and 4m.

Fig.8 Pro 1.9 SPL measurements at different distances @1W: 4m-blue green, 3m-green, 2m-dark blue, 1m- red

The red lower curve is a 1m measurement. All other curves were scaled according to inverse square law (-6db per doubling distance) accounting for the distance, to produce a curve equivalent to 1m measurement. It means, for example, that the 2m curve was scaled up +6dB and the 4m curve was scaled +12dB. If the Pro 1.9 were a point source device all curves would have had the similar level as the 1m curve. Not true however in this case. It is clear that the Pro-line at 4m (light blue) lost only 6db of SPL (the average difference between the 1m curve and the 4m curve from 700Hz and up) instead of 12db. This is the perfect illustration of how Pro-line works.

Pro-line directivity and dispersion

Another unique feature of the Pro-line loudspeakers is their dispersion pattern. Simply put, the Pro-line has very controlled vertical and quite wide and constant horizontal dispersion. This kind of dispersion is ideal for many applications including home theater.

Fig.9 shows vertical directivity isobar plot of Radia Professional Speakers Pro 1.9 in enclosure.

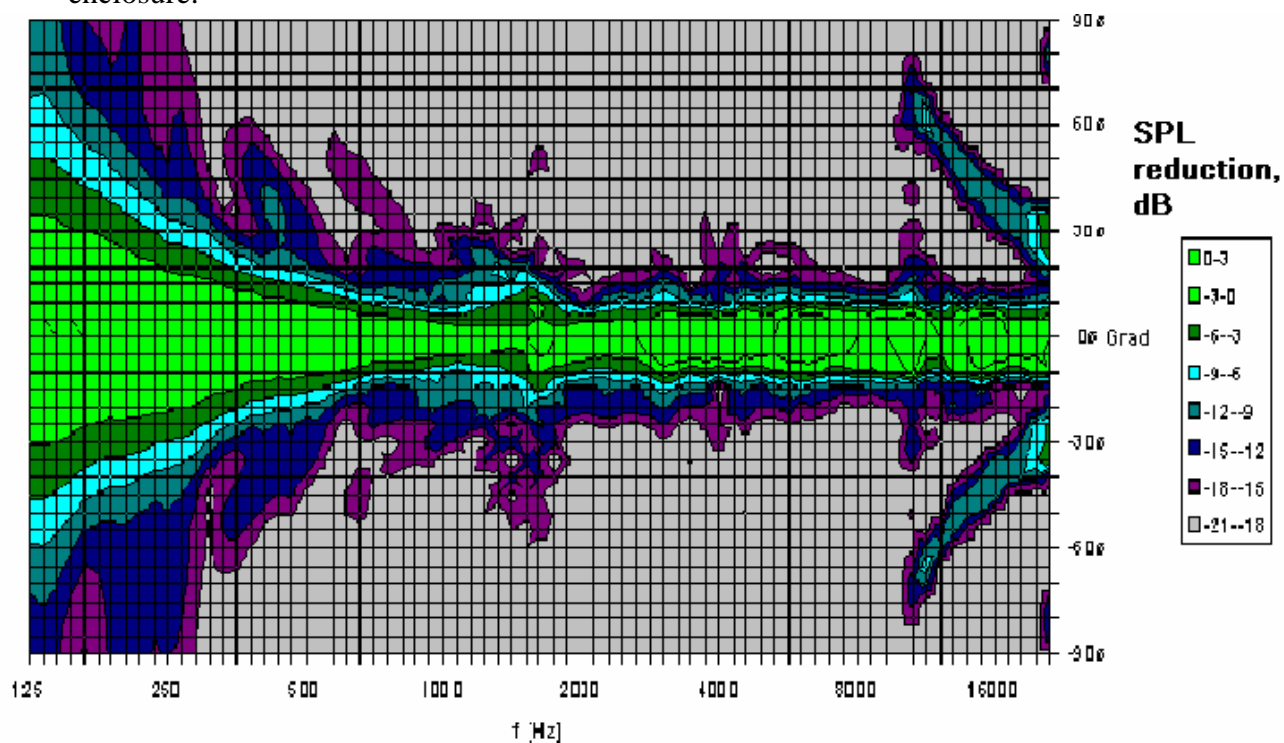


Fig. 9 Pro 1.9 vertical dispersion in enclosure

The Pro 1.9 offers the most controlled wide band vertical dispersion available from a single commercial loudspeaker. This tells us that the Pro 1.9's vertical dispersion mostly corresponds to its length (height if Pro 1.9 is installed vertically). As soon as one starts moving away from either of its ends, the radiation level drops drastically. In terms of

beam width (-6dB level reduction), we can say that Pro 1.9 has 20° dispersion control from 500 Hz up. Note, that the beam width is amazingly constant. This allows for superior control of the coverage area, unavailable from any other loudspeaker. Below 500 Hz dispersion gradually widens, and at 150 Hz this loudspeaker has 60° dispersion control.

Finally, it is possible to have low frequency dispersion control from a single loudspeaker. Fig. 10 shows horizontal dispersion of a Pro1.9 in an enclosure.

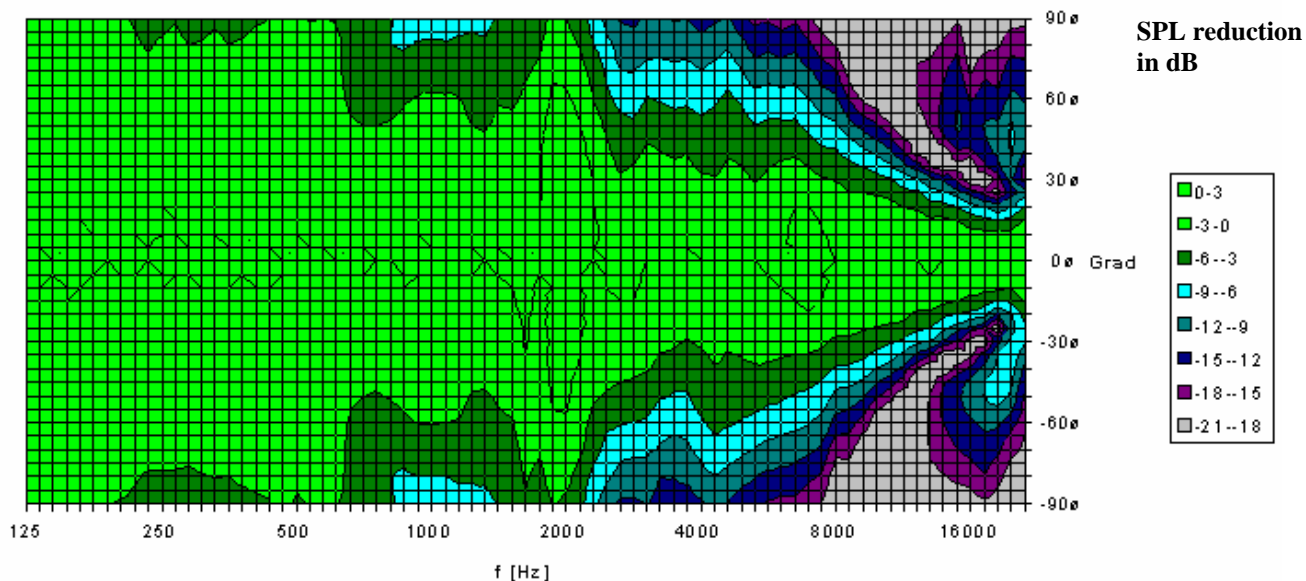


Fig. 10 Pro 1.9 horizontal dispersion

All Pro-line transducers have the same very narrow radiating area (less than 1 ¼"). Therefore the horizontal dispersion is quite wide, ranging from 180° below 700 Hz, through 120° in the midrange band to about 60° at high frequencies. This pattern allows wide coverage of a venue area by a single system without building angled clusters.

It should be noted, that the Pro-line driver in an enclosure, represents a monopole radiator, while without an enclosure it behaves as a dipole. As a dipole, a Pro-line transducer has less output in the lower frequencies (150-400 Hz) and possesses a figure eight dispersion pattern. Some possible applications of Pro-line in a dipole mode will be discussed below.

The Pro-line system versus other conventional line array loudspeakers

The benefits of a line source radiator have been recognized before WWII, when in 1939 RCA developed the first column loudspeaker array. Currently, many manufacturers of professional systems and a few in the high-end consumer market develop and make

vertical line array loudspeakers in an attempt to duplicate the characteristics of a line source system.

The truth is that none of these systems is a line source by definition, despite all the elaborate mechanical and electronic efforts made to shape, delay, attenuate or even squeeze the sound into narrow wave-guides. What all these expensive and complex products are trying to replicate, are the Pro-line radiation characteristics.

The main problem with conventional line array speaker is that the sound is not radiated by a single continuous source over a wide band as in the Pro-line system, but rather by a discrete number of physically separated drivers with limited bandwidth and crossovers in 1-2 kHz region. This arrangement inevitably leads to severe frequency dependant lobing, phase cancellation and comb filtering because it is impossible to satisfy proper array coupling conditions over a wide frequency band. Therefore, in every case a discrete vertical array loudspeaker is a compromise.

There are a number of manufacturers that develop DSP based "shaded arrays" or "beam steering" systems, in order to gain control over the drivers' dispersion in an array. Mostly, these systems are based on delivering a different signal to each driver within the array. The further a driver is from the center, the less midrange information it receives. There are even more complex ideas that use DSP processing for applying particular gain and phase coefficients for each array transducer, putting a loudspeaker closer to submarine sonar. Even with all these elaborate improvements line array systems will be only a distant approach to a line source radiator.

The Pro-line system, as was shown above, possesses all the qualities of a line source. It doesn't have lobing or comb filter effects. Since the line source has perfectly controlled vertical dispersion, without parasitic reflections from ceiling and floor, Pro-line delivers more direct sound energy to the listener. This not only greatly improves quality and intelligibility, but also increases localization in stereo and creates accurate visual clues to the source.

Diffraction

The complex mechanical design of traditional line arrays with woofers, horn loaded compression drivers and deep wave-guides increases diffraction of sound on various discontinuities of the system's surface. Significant diffraction and reflections from nearby surfaces lead to unbalanced, "honky," blurred and muffled sound.

Radia Professional Speakers Pro-line loudspeaker is probably the slimmest and least obstructive professional system. It has a very narrow profile and measures only 4.7 wide, has rounded corners and minimal distance from radiating diaphragm (acoustic center) to the baffle surface. The Pro-line has the least diffraction problems and distortion of any PA system on the market. There is almost nothing around the diaphragm to cause signal reflections. This is another reason why the Pro-line sound possesses transparency and high resolution.

Applications and benefits

Today's audio system design and installation presents a significant challenge. A designer should find an optimum solution considering all factors in a project. Very often the choice, location and implementation of a system are dictated not only by acoustical concerns or a budget, but also by architectural requirements, aesthetics, and customer preferences and so on.

The scale and success of the Radia Professional Speakers Pro-line systems application can be appreciated from a proper understanding of the system operation and resulting benefits. Unique qualities of the Pro-line loudspeakers offer extensive application possibilities without compromising the most important performance parameters.

We already discussed the Pro-line cylindrical wave radiation and extended coverage zone where the special $1/\sqrt{r}$ rate of SPL reduction is applied. One could easily use the above formulas to calculate the near field range for a particular Pro-line speaker. Thus, knowing loudspeaker sensitivity and amplifier output power permits one to predict SPL readings at the front and the rear of the intended coverage area at different frequencies.

Coverage angles could be taken from vertical and horizontal directivity plots (Fig. 9 and Fig. 10 respectively).

One must always to keep in mind that the Pro-line speaker produces a uniform radiation front as soon as the listener is "covered" by its sound beam that is equal to the length of the transducer (see Fig. 11).

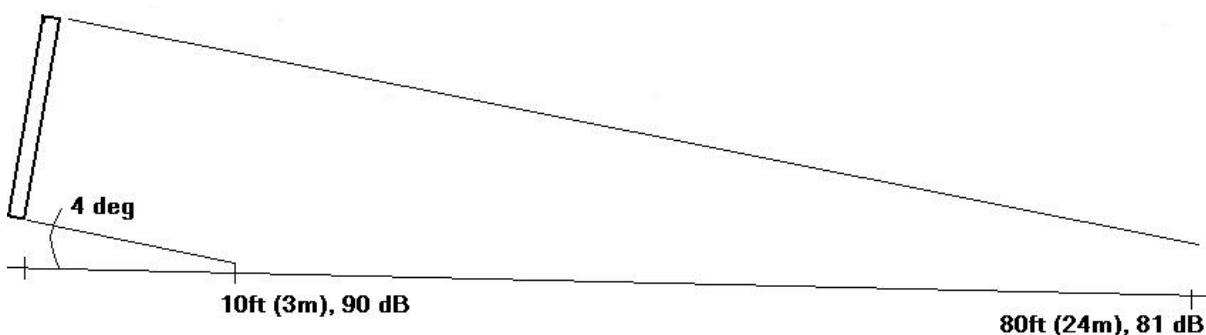


Fig. 11 Example of the Pro 1.9 coverage area calculation

In the case shown in Fig.11 we need to provide 94.8 dB SPL at 1m, to get 90 dB at 3m and 81dB at 24m. How much power does the amplifier have to deliver? With the Pro 1.9 having 90dB/1W/1m, we need just 3W. It is possible to change angle, height or stack another Pro 1.9 in line in order to satisfy virtually any coverage requirements. Beyond the edge of the beam we need to consider dispersion patterns. In the vertical plane (along the length of the driver) it is extremely controlled at $\pm 5^\circ$, providing easy and accurate performance predictions. In the horizontal plane dispersion is wide and consistent, providing wide horizontal coverage and an expanded "sweet spot" for stereo or a home theater set up. It is necessary to mention that given calculations describe the Pro 1.9

transducer at upper range of a vocal frequency band (1.5 kHz and up). At lower frequencies the Pro1.9's near field will have shorter range. However, most of intelligibility and coverage problems are dictated by the critical range above 1.5 kHz and therefore it is rather informative to use this range for all acoustic predictions.

The Pro-line is unique in a way that it has very controlled vertical dispersion and therefore it delivers maximum clarity of the radiated sound. At the same time it has wide horizontal dispersion and retains lateral energy, thus creating a very good spatial impression and envelopment.

With Pro-line applications one can virtually forget about floor and ceiling reflections. The ability to project sound directly to the audience without these reflections plays an immense role in achieving excellent clarity, intelligibility and localization. It enables a designer to adjust the position of the Pro-line in order to avoid unwanted reflections. This approach can provide broadband pattern control that may bring solutions in venues that were out of reach for conventional loudspeaker designs.

Examples where the Pro-line can bring a solution in a challenging project are endless:

- low ceilings
- hard reflective floor
- feedback problems can be easily resolved with a Pro-line positioned in-line with a microphone. It is noticed and demonstrated that Pro-line systems has amazingly high feedback threshold even when a microphone is placed in close proximity (2-3 feet) right in front of the system. As a result, very high gain before feedback levels can be achieved with the Pro-line systems in many challenging situations.
- sport facilities, churches and other venues where stone walls, glass, metal surfaces etc. create very high reverberation. The Pro-line will have better C50 and C80 parameters and thus better clarity and intelligibility, than any other system facing these conditions
- visual cosmetic limitations and other special aesthetic considerations. The Pro-line is easily and seamlessly integrated within a venue
- any setting where there is a need for even and wide horizontal coverage
- creation of the sound source "moving" with a listener, when Pro-line is stacked horizontally in a long ceiling or wall installation
- creation of perfectly continuous sound sources covering extended areas, to achieve exactly the same SPL in each point along the area
- creation of extremely isolated zones of sound, intended for a particular display or setting (museums, stores, exhibitions, localized sound effects, designated "sound corridors" adjacent to each other with different sound programs etc.)

The list of applications is limited only by a designer's imagination.

It is very common today to see large venues stacked with arrays of speakers. This practice is used to obtain high SPL levels to the rear of the coverage area. With poorly coupled multiple arrays coverage problems often occur and SPL consistency, intelligibility and general sound quality all suffer. The speakers inevitably have acoustic energy leakage and consume substantial or excessive power. Very often these arrays can be substituted by just two channels of Pro-line speakers, single pair or stacked vertically

to a required length and angled for proper coverage. In such cases one could often receive better results with fewer speakers, using Pro-Line. In a typical large room installation, one pair of Pro 1.9's creates an extremely consistent SPL coverage. One can hardly notice a significant loudness variation, moving from the very end of the coverage area to directly in front the speakers. The same is true in a lateral direction. Experiencing a clear and evenly balanced sound regardless of listener position brings an amazing feeling of comfort and psychological relief to the listener.

Pro-line loudspeakers, being a continuous and coherent line source will have less energy consumption, better overall efficiency, better SPL consistency, better quality and intelligibility, better look and less listening fatigue.

Normally a Pro-line transducer should be used in a closed box. However, they can be used in a dipole mode as well. The very specific application for a Pro-line speaker in a dipole mode (in open baffle or without) would be a situation where minimum radiation in $\pm 90^\circ$ (to the sides) down to low frequencies is required. In a dipole mode Pro-line will not radiate sound towards the sides ($+90^\circ$ and -90°) even at the lowest frequencies, thus totally eliminating reflections from the adjacent surfaces. However the absence of an enclosure will result in reduced low frequency output and figure eight dispersion pattern. For example, if you have a microphone positioned on the line between two dipoles you could achieve very high levels of overall audio system gain without creating feedback problems. Another interesting application of the Pro-line loudspeaker in a dipole configuration is the creation of diffused sound, when a listener doesn't know where the sound source is located. In this case you must position the Pro-line speaker turned 90° towards the listener. The results are very impressive.

One unique application, possibly achieved only with the Pro-line drivers, is the creation of so called "sound corridors", or, in other words, strictly isolated in space sound beams. Usually in this case a Pro-line driver is located horizontally, thus having sound projected only in restricted area corresponding to its length. Fig. 12 depicts a general layout of this type of installation.

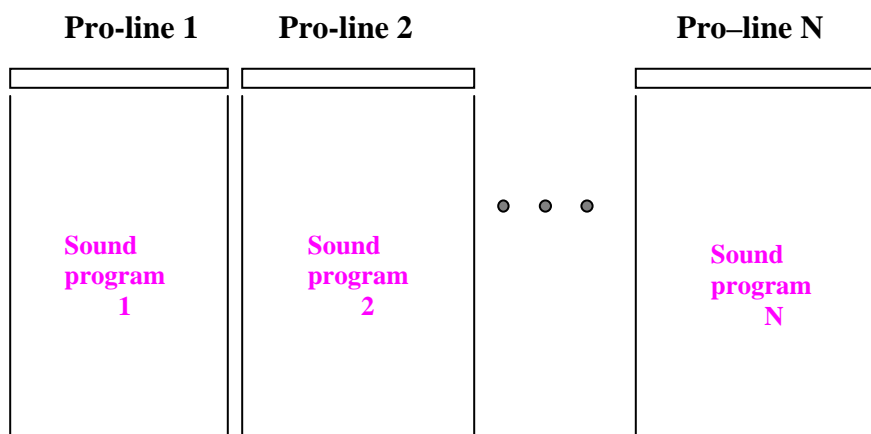


Fig12. Pro-line speakers in a "sound corridor" application

In this unique application Pro-line speakers can be installed horizontally either in ceiling or in wall. Each Pro-line can correspond to a screen, broadcasting a particular program, or any other object of interest. Within each “sound corridor” a listener will hear only the sound related to a particular object. The effectiveness of this kind of installation is fascinating. There can be only one object with several “sound corridors” reproducing a different program related to this object (e.g. in different languages). There is no limit for such “sound corridor” applications with the Pro-line.

The time has come to shift a paradigm of our perception and thinking about professional sound only in terms of SPL, coverage and “throw”. Now, one must also think in terms of qualities that provide emotional and physiological results. With audio technology experiencing amazing advances in quality and fidelity of electronic components and recording media, loudspeakers cannot stay in the “glory” of 50-year-old technology, being an anchor for the ship of better sound.

Radia Professional Speakers Pro-line loudspeakers are created for people who seek better sound, better and more intelligent solutions for their projects, who now have an opportunity to use these products creatively. Radia Professional is not selling technology. Radia Professional is selling solutions that its technology can bring to one’s real business challenges.

Text and drawings by Igor Levitsky
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