SOUND AFFECTS!

Julian Treasure

Sound Affects!

Introduction for Sound Affects!

I have long felt that the audio industry has done itself harm by neglecting to communicate the importance of sound in everyday life. Audio gets overlooked and undervalued when compared to lighting, interior design, video or control, and yet sound affects people's work and personal lives, in terms of both productivity and enjoyment.

I met Julian Treasure at TED Global 2010 and he was the first person that I'd met who'd made a career out of selling the value of sound to business. It has been a pleasure to work with Julian on this book. Intended to communicate the value of sound and to elevate its importance to anyone looking to communicate through technology, Sound Affects is a gift to our industry and our customers.

Graeme Harrison,
Biamp Systems

The aim of this small book is to refocus on the A of AV, exploring why sound quality matters in business and acting as a guide to achieve the best results when installing it.

Sound Matters!

When Biamp's Graeme Harrison approached me to create a handbook for anyone thinking about installing a professional sound system I was delighted, because I have experienced so many commercial spaces, from shops and offices to schools and transport terminals, where poor sound is having devastating effects on sales, on communication, on productivity, on customer satisfaction, or on wellbeing.

This is a big issue.

We can communicate perfectly well in good quality sound alone; the same is not generally true of video. All too often, commercial insta-lations get diverted by the glamor of the latest video innovation, whether that's HD, 3D or whatever comes next, and forget to deliver sound quality to match. We live in an increasingly noisy world, partly because most architects and designers focus exclusively on the eyes, which means that far too many of our spaces sound terrible.

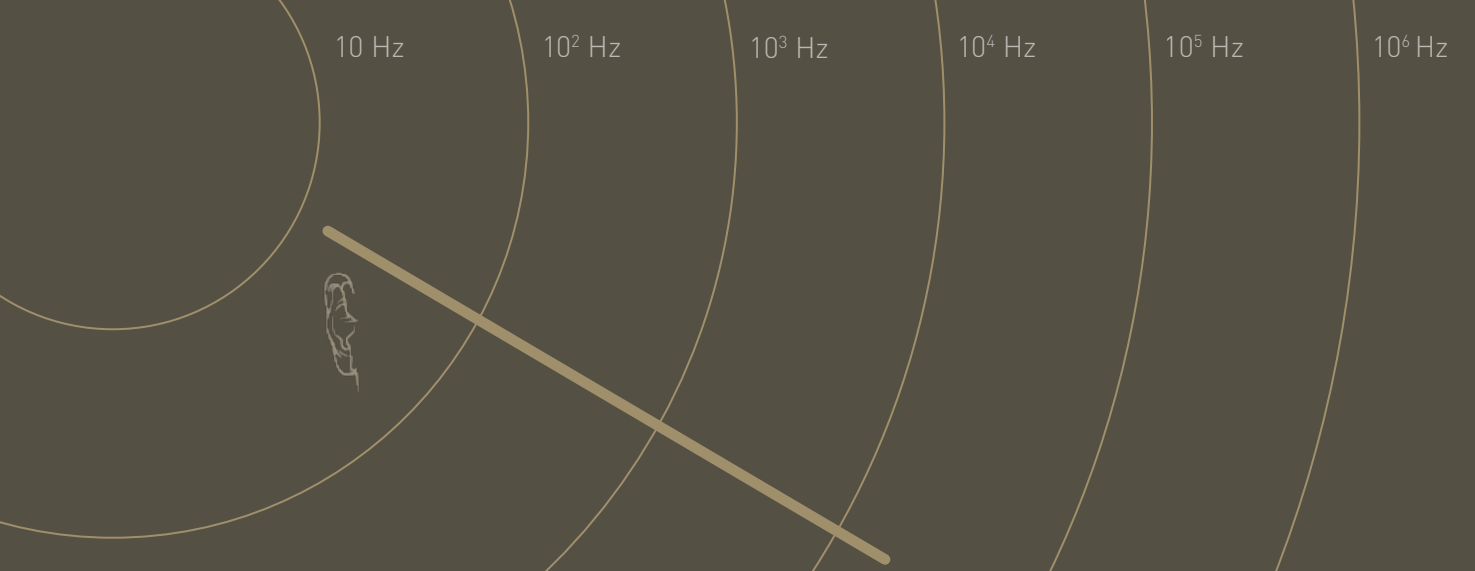
The aim of this small book is to refocus on the A of AV, exploring why sound quality matters in business and acting as a guide to achieve the best results when installing sound systems. It's not a technical manual, though it does contain a lot of invaluable, hard-won practical advice from the experts. Any technical terms we had to use are flagged with an * which means they are explained in a useful glossary at the back.

Whatever your level of technical knowledge, there should be something in here for you – and all of it will pay off, whether in increased sales, in happier customers, or in a more productive and less stressed workforce. Good quality sound is simply good business.

Julian Treasure,
The Sound Agency

Julian Treasure is author of the book 'Sound Business' and Chairman of UK-based BrandSound™ consultancy The Sound Agency, which numbers Harrods, Nokia, Coca-Cola and BP among its customers.
Julian's three TED talks about sound have been viewed an estimated three million times.

Visit www.juliantreasure.com or www.thesoundagency.com for more information.



Range of sound frequencies for humans

Sound

Sound is audible vibration that's carried through a medium. We're used to assuming that the medium is air, but in fact sound travels twice as fast and much further through water than through air, which is how some whales can communicate effectively over vast distances. Metal is an even better sonic medium.

Sound is just one type of vibration. Vibration is living energy: only inert, dead things are perfectly still. From the largest cosmic object to the tiniest subatomic particle, everything in the universe is vibrating – including you. As you read this, every atom, molecule and cell in your body is vibrating, creating a rich chord that's unique to you.

One model of ill health defines it as disharmony in this chord.

A human with excellent hearing perceives a spectrum from about 20 Hertz* (Hz) to 20 kHz. Almost every sound we hear comprises rich harmonics – overtones that we may not notice, but that are essential in producing the timbre and the meaning of the sound. That's how we can discern one person's voice from another, or read the emotion embedded in a spoken word. These overtones go all the way up the audible range and above,

◊ **Speed of sound in sonic media**

10^7 Hz 10^8 Hz 10^9 Hz 10^{10} Hz 10^{11} Hz 10^{12} Hz 10^{13} Hz

20 Hz 2:1 2:1 2:1 2:1 2:1 2:1 2:1 2:1 **20 kHz**

The maximum human audible range is 10 octaves. Each octave is an exact doubling of frequency.

We perceive octaves as the same note because of this exact doubling of frequency. A higher octave's waveform contains the frequencies of all all the lower octaves.

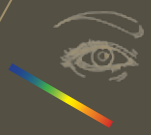
The notes of a 'perfect fifth' have three and two vibrations respectively in the same time, also resulting in a smooth and consonant sound.

which is why it's harder to understand people when their voice is crudely filtered, for example on the phone: we simply don't have the information we need for clear comprehension if these overtones are missing.

The properties of the harmonic series are intriguingly fundamental. First discovered by Pythagoras, later investigated by Kepler, the ratios of the frequencies of the notes in intervals we find pleasing always involve whole numbers (for example an octave is 2:1; a perfect fifth is 3:2 and so on). If we make sound visible by passing it through a metal plate with sand on it (a process known as cymatics), the patterns formed are symmetrical, beautiful and reminiscent of natural shapes such as snowflakes or flowers.

We can't make light, but we can make sound. Sound is part of what we are. Isn't it strange that we are so unconscious of it?

Our visible light spectrum is just one octave (3.1×10^{14} - 7.1×10^{14} Hz), but we can hear 10 octaves of sound.



Tips & traps

We've interviewed some of Biamp's partners around the world to bring you sound advice (pun absolutely intended) on the practicalities of installing and configuring systems in different places. From tips and tricks to cautionary tales, these sections form an invaluable store of wisdom. In each environment we asked the experts for their top tips (shown here as TIPS) and common errors to avoid (TRAPS). Many of them will apply in more than one situation. They are all hard earned in the field.

Conference rooms

Verbal communication is the whole point of these spaces – and yet they are so often fashioned for the eyes alone, with little or no acoustic design and no integration of the AV system at the design stage. Good conference room sound doesn't just happen: small room acoustics are among the most challenging to get right, so it's not easy to achieve a transparent sound for audio- or video-conferencing. But the return on a proper investment in sound is massive: poorly-performing conference rooms just make a company look and sound bad, whether it's staff or major clients at the other end of the call, and uncomfortable spaces tend to make meetings go badly. The investment in an excellent conference room sound is simply business-critical. Remember, if your video fails you can communicate perfectly well in sound, but the reverse is not true!

TIPS

√ Get the acoustics right first: correcting major acoustical problems with technology doesn't often work.

√ Install ultra-quiet heating, ventilation and air conditioning

(HVAC): specify under 40 decibels* (dB) of noise at one meter. Noisy air conditioning is the most common sound problem in conference rooms.

√ Integrate the conferencing AV system within the architect's design from the start.

√ Use appropriate microphones (mics) to capture wanted speech and minimize background noise.

√ Train all relevant staff to become masters of the system so there are no clunky moments in critical meetings.

√ Provide plenty of easy inputs and preset configurations for all possible devices.

TRAPS

× Retro-fitting... the sound system is not an add-on; it's the point!

× Assuming that a big, impressive screen equals a great conferencing system: for intelligibility, sound matters more than sight.

× Skimping on quality – damaging because the experience of this system will define how the company comes across.

× Making the system complex to manage, which can often lead to fumbling, awkward interludes where people try to activate some feature.

Thanks to Jerry Davis (Jeremiah Associates, USA)

Tips & traps

Auditoria

In most auditoria, very few seats offer perfect line of sight – but with good system design we can ensure that up to 80% do offer a perfect auditory experience. Sound creates at least half of the overall impact for any audience; they should be able to close their eyes and still enjoy the event. An appropriate and well-tuned sound system can create a good experience for most of the audience, even if the acoustics of the auditorium are not ideal.

TIPS

√ Focus on the main purpose of the auditorium whenever choices have to be made (for example theaters usually prioritize clarity over fullness).

√ Make sure the sound system is designed with the actual acoustics always in mind: there are different solutions for high and low reverberation spaces.

√ Bring in pro audio people as early as possible, ideally between schematic design and early detailed design.

√ Design in a 'digital snake' from the start, because cable runs can be tricky, ugly and costly if left until last.

√ Plan for a sound mixing position in the center of the

auditorium, not in the back row under a balcony!

√ Employ experts whose passion is to tune and optimize the system continually at every stage from initial design to the commissioning of the Digital Signal Processor* (DSP).

TRAPS

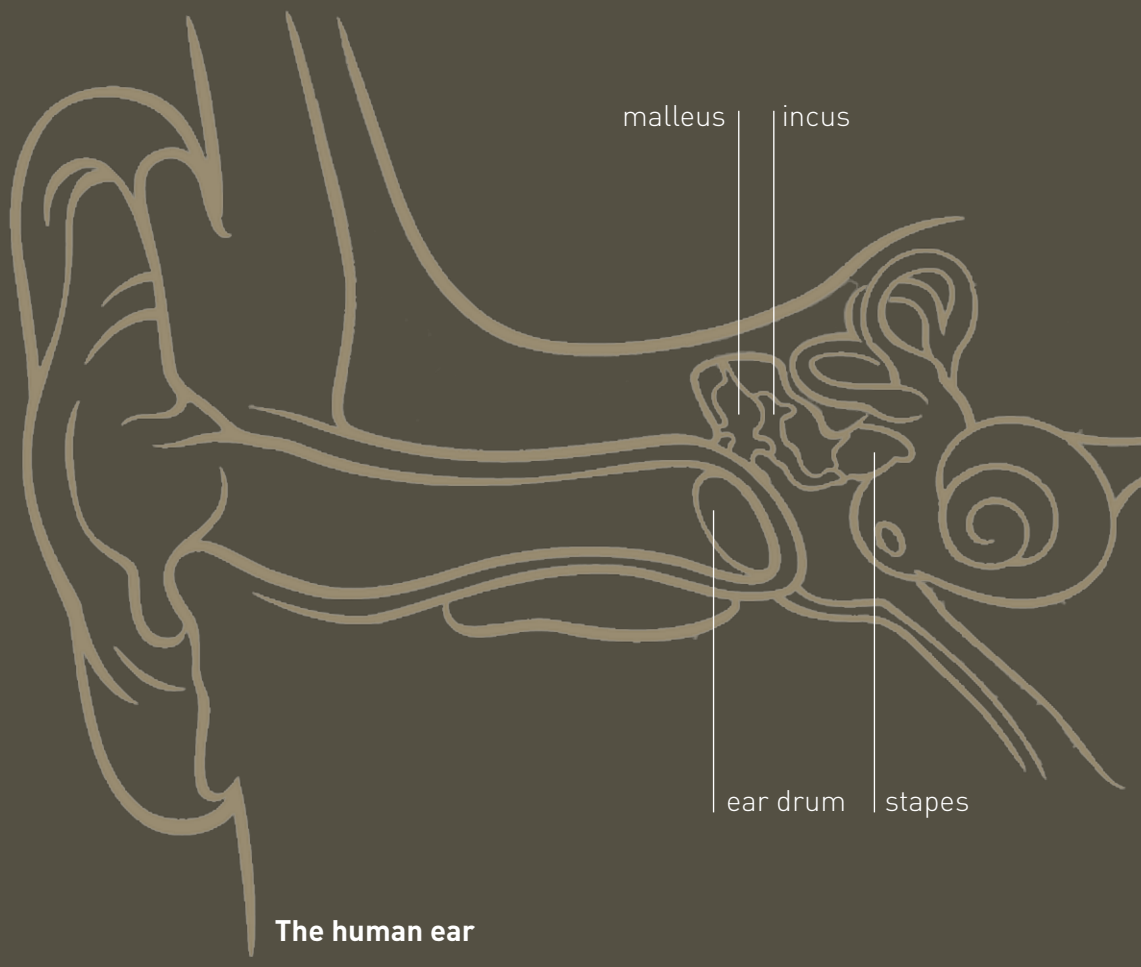
× Letting people tell you that line arrays* are a panacea that will solve every problem. In fact they can create excessive sound energy at the side walls. Point source clusters* can work better for small arenas.

× Forgetting that loudspeakers interact with one another: for example beware of proposals to install any arrays without using modeling software to optimize them.

× Mounting loudspeakers next to physical obstructions: this will probably create unpleasant audio effects.

× Letting power and signal cables be run next to each other: they need to be seperated.

Thanks to Zane Au (Shen Milson Wilke, Hong Kong) and Deward Timothy (Poll Sound, USA)



The human ear

The loudest sound we can tolerate is one trillion times as powerful as the quietest sound we can discern. Visualized, this is the difference between a dot with a diameter of 1 mm and one with a diameter of 1 000 000 km.

Hearing

Hearing is the first sense we develop: just 12 weeks after conception, before our ears have developed, we start to hear with every cell. Each of us still hears that way now, with all of our skin, bone and muscle – though of course the ears are our specialist hearing organs.

And what specialists they are! Our audible spectrum is up to 10 octaves: by contrast, we see just one octave of the light spectrum. We hear in a complete sphere around us, locating sounds in space by calculating tiny differences in their arrival times at each ear. The loudest sound we can tolerate is around one trillion times as powerful as the quietest sound we can discern.

Our hearing process is miraculous. Think about it: sound waves touch you right inside your head, causing your eardrum to vibrate. That small membrane oscillates fluid in your middle ear, activating three tiny interlocked bones – marvels of engineering that never stop moving from before birth to your final breath, tirelessly vibrating thousands of times a second and passing those vibrations on to the little hairs of your inner ear, each of which, it is now thought, detects a separate frequency range, translating it into an electrical impulse for the brain to decode. This decoding is extraordinary in itself, unpacking as it does the richness, subtlety and variety of all the millions of different sounds we encounter in our lives, as well as locating every one of them precisely in space.

Hearing is our primary warning sense. It's hard wired into our primal brain, traveling direct to the instinctive limbic region and not to the rational, interpretive cortex where visual signals are decoded. That's why it's far easier to upset someone through their ears than through their eyes: sound goes very deep, very fast. And remember, we have no ear lids: our hearing is working even while we sleep, carrying out its primary mission, which is to detect danger.

Hearing is passive, an automatic system. Listening is another thing altogether: it's a skill, and one that we are in danger of losing.

Listening

Listening is making meaning from sound. It's the active mental process that interprets those thousands of neural impulses triggered by the sound waves that touch us, assembling this complex matrix of information into a soundscape that we can understand and act upon.

All of us listen through a set of filters, though most of us are completely unaware of them. These include our culture, language, beliefs, attitudes, expectations and intentions. They have profound effects: we may simply not perceive things that fall outside our filters. For example, thinking that we know someone well, we can fix our listening for him or her, unconsciously choosing to hear only what conforms to this listening (thus reinforcing our belief about them) and not what conflicts – so we effectively deny them permission to change.

When we form strong, fixed expectations based on politics, ethnicity or the like, we deny entire groups their real richness and variety by just not hearing them fully. This denial can even become physical deafness, known as stress induced auditory dysfunction: a sadly all-too common example of this is the man who becomes deaf at the frequency of his wife's voice.

Research shows that most of us aren't very good listeners when it comes to communication: we spend up to 60% of our communication time listening [a], but we retain just 25% of what we hear [b]. Even this level of performance is under threat.

Our society is increasingly impatient, preferring soundbites to oratory and wanting the payoff now. As we add volume and inputs (mp3, phone, screen, pad...) we create a noisier world and we desensitize ourselves, making it harder to hear the quiet and the subtle.

Our media shout; our movies explode; our need for speed creates transport noise that robs us of our health (noise in Europe is costing one million years of healthy life each year, according to the WHO) [c].

Ubiquitous headphone use is fragmenting what were once shared social soundscapes into millions of tiny personal sound bubbles, as well as damaging our hearing (one in eight American teenagers has noise induced hearing loss, almost

One in eight American teenagers has noise induced hearing loss, almost certainly as a result of headphone abuse.

certainly as a result of headphone abuse) [d].

We must work to regain our listening, because it allows us to be aware of our sonic environment, and so enables us to design it so that it supports us.

Fortunately, we can all develop our conscious listening by using five simple exercises.

Silence

Just three minutes a day works wonders, resetting your ears just as a sorbet resets your palette in a meal. If you can't get silence, just use the quietest place you can find.

The mixer

Wherever you are, try to distinguish how many different channels of sound you are hearing. This is a great exercise for refining your listening.

Savoring

Relish mundane sounds by listening with conscious attention: this can unlock the hidden choir in (for example) your kettle boiling!

Listening positions

A listening position is metaphorical, not physical; it arises as we change the settings on our listening filters. The trick is to be aware of those settings and able to move them. If you listen from a different place, your whole reality can change.

RASA

In conversation, this acronym stands for: Receive (show that you're paying attention with eye contact and body language); Appreciate (make little noises to give aural feedback, especially on the phone); Summarize (the word 'so' is very powerful); Ask (when they've finished, ask questions to clarify and express interest).

Conscious listening is an essential skill, whether you are an audio professional, a business executive, a manager, a parent or a friend. If you listen consciously in business, you are well ahead of the competition, and you can start to design soundscapes to increase sales, productivity, wellbeing and customer satisfaction... because sound affects us all profoundly, even if we are not aware of it.

Tips & traps

Education

The spoken word is crucial for understanding, and yet many children sit at the back unable to hear more than one word in two. Our challenge is getting even greater as modern education moves towards a collaborative environment – so now groups work together, which can create cacophony. We owe it to our children to deliver 100% of their education, wherever they sit. All that's at stake is the future!

TIPS

√ Prioritize intelligibility over everything else.
Set uncompromising goals for speech intelligibility (SI) and have it measured after installation to ensure they've been met.

√ Have the space modeled – or if you can't afford that, check that your supplier has carried out simple but essential calculations like PAG-NAG (potential acoustic gain - needed acoustic gain)* to prevent feedback.

√ Specify simplicity as an essential criteria. The operators are probably not going to be trained or expert.

TRAPS

× Making content a scapegoat for poor performance (to excuse, for example, an improperly set gain structure).

× Using omnidirectional mics for everything: it's vital to define and use the right mics for each usage.

× Forgetting the need for acoustic treatments, which are often necessary for maximum intelligibility.

Thanks to Bill Nattress (Shen Milsom Wilke, USA)

Tips & traps

Hotels

A hotel is a theatre with front and back of house, and all five senses are involved in delivering the ideal guest experience. How strange, then, that many hotels still install low-cost ceiling speakers in bars and lounges regardless of varying room heights and acoustic properties, and that some function rooms have unbearable acoustics, or no sound system, or both!

TIPS

√ Design every space acoustically as well as visually: a really bad room can turn even a good sound system to mud. Some large ballrooms have reverberation times as long as eight seconds, more fitting to a cathedral than a function space!

√ Aim for maximum reverberation time* (RT) of one second in all public areas, and 0.5 sec in spaces smaller than 500 ft^2 (50 m^2).

√ Treat ambient noise sources to achieve a low level of background sound from the room itself. The target should be NC35* (retain an acoustician to check this), which means optimizing every noise-making device (HVAC, water features, projector fans, chillers etc) and choosing surfaces that absorb, as opposed to reflect, noise.

√ Plan for all eventualities, so install a system that can cope with anything.

√ Specify the use of some audio compression on the content if you need to make it continuously audible over varying levels of people-generated noise or use Ambient Noise Compensation* (ANC) to adjust the levels automatically with varying ambient noise levels.

√ Require that your suppliers provide signed-off cable check lists as part of the handover document to ensure correct polarity*: loudspeakers that are out of

polarity can cancel out large bands of frequency response due to phase cancellation.

TRAPS

× Leaving sound for later: to rent a sound system for every function will cost far more in the long run.

× Making it complex for guests to connect their own sources to in-room systems.

× Prioritizing cost at the design stage: it will cost far more to fix a poor system when guests and clients are complaining about sound.

× Cutting out acoustic measures or vital components like DSP or equalizers to 'value engineer' major spaces in build or refit: the effect on customer experience will be both severe and long-lasting.

× Accepting a proposal that's under-powered. Your supplier must allow for the additional 6 dB needed for equalisation of the room, 3 dB for the loudspeaker non-flat frequency response, 2 dB for the 100/70Volt transformer, and +6dB headroom... all of this adds up to 17 dB of gain required on top of the desired dB level 'at ear'. This is all too easy to miss in a proposal, and very expensive to rectify later.

× Using simply 'dollar per watt' calculations to choose amplifiers. This is far too simplistic: manufacturers rarely provide directly comparative specifications.

Thanks to Ian Harris (ihD, Hong Kong) and Stephanie Adams Ball (David L Adams Associates, USA)

The four effects of sound

Let's unpack exactly how sound affects us. It does so in four ways.

Physiological

The sound around us changes our heart rate, breathing, hormone secretions and even our brain waves. In the main this happens through entrainment, the gravity-like process whereby a large, strong oscillator will bring a smaller, weaker oscillator into step: for example, if I drop you in a night club where loud music is playing at 140 beats per minute, your heart beat and breathing rate will immediately start to accelerate. Gentle surf, at about 12 cycles per minute, has the opposite effect. Sudden or unexpected sounds trigger your fight/flight reflex, traveling instantly to the limbic system and triggering a release of cortisol. By the time our cortex send the reassuring message that it's just a car backfiring, it's too late: the reflex has already done its work and the hormone is already in our system. Constant overdosing with cortisol may be a cause of many of the health complaints found in our cities, from gastric issues to high blood pressure, depression and sexual dysfunction.

Slow-paced sound can increase retail sales by 38%

Psychological

We all know how music changes our mood. Play your happiest or saddest piece of music, even just in your head, and your mood changes dramatically. Music is a potent 'essentic form', carrying within it the emotion encoded by the composer and performer. Nobody quite knows how it works, but every human society throughout all history has made and used music: clearly, to be human is to be musical, whether we understand the process or not. It's not just music that affects our mood: some natural sounds also have a psychological effect – for example, birdsong makes many people feel secure because we've learned over hundreds of thousands of years that when the birds are singing, our environment is safe. It's when they stop that we need to be worried! At the same time, birdsong tends to make us more alert because the birds are nature's alarm clock.

Cognitive

We're all familiar with feeling overwhelmed when we try to concen-

trate in a noisy, distracting place. This happens because we have very limited mental bandwidth for audio input – which is why you can't understand two people talking at once. Both writing and reading involve internal vocalization and symbol manipulation; if you can hear someone speaking at the same time, that input takes up your valuable processing space and your productivity nosedives by up to 66%, according to the research [e]. Many open plan offices are highly unproductive as a result. We urgently need to create quiet working spaces, as well as open, team working areas, social spaces and meeting spaces. More generally, we need to persuade architects and interior designers to start putting experience first and appearance second when they make spaces for people to live, work, learn and play in.

Behavioral

Due to entrainment, our whole pace of movement changes with the sound around us. Just think what happens to your driving style if you play loud, pumping, adrenalized music in your car. Many shops and retail centers are losing huge amounts of money by not understanding this process: they play fast-paced pop music in the wrong belief that 'buzz' creates sales, whereas what they are actually doing is to speed people up and thus reduce dwell time – and every retailer knows that dwell time correlates directly with sales. The research concurs: it shows that slow-paced sound can increase retail sales by up to 38%! [f]

At the most basic level, we tend to move away from unpleasant sound, and towards pleasant sound. Retail sound systems that deliver loud, tinny or distorted music are causing people to leave faster, or not even to enter the premises in the first place. Forcing people to remain in places with unpleasant soundscapes simply creates stress, irritation and negative social interactions. Good quality sound, on the other hand, is attractive and will encourage people to linger and interact positively.

Not only does sound affect us on its own: it also changes the effects of all our other senses through a little thing called super-additivity.

If you can hear someone speaking while reading or writing it takes up your processing space and your productivity nosedives by up to 66%

Tips & traps

Convention Centers

The whole point of a convention center is to facilitate people communicating and buying from one another – all of which is severely impeded if a bad sound system leaves them hoarse from shouting after an hour or two.

TIPS

√ Discover from the client all the past and possible future uses of the space, and what the acoustic strengths and weaknesses have been.

√ Use the smallest practicable zones for maximum flexibility.

√ Create multiple DSP presets for different situations (remembering to create a simple, zero-maintenance default preset for system reboot).

√ Use networked systems (e.g. Audio Video Bridging* (AVB) or CobraNet*) to localize inputs; have drop points around the area so you can plug in preconfigured modular stage boxes. This means you don't need so many conventional floor boxes and gives you maximum flexibility.

√ Work in a team with the architect, interior designer, client and relevant staff.

TRAPS

× Assuming you know all the space's possible uses: there are often surprises!

× Overpowering the space. The system should be transparent – in other words, people should never be consciously aware that there *is* a system!

× Ignoring the need to correct acoustics and noise sources – unobtrusively of course.

Thanks to Michael Schwartz (Deliberative Design, USA).


CITR

Super-additivity

The latest research from scientists such as Professor Charles Spence at Oxford University is revealing the extent that our senses affect one another. These so called crossmodal effects have revealed that creating congruent messages produces an effect that's not just additive: it's super-additive – in effect multiplicative.

For example, neuroscientific research shows that adding congruent sound to visual communication increases impact by just over 1100%. However, adding incongruent sound reduces impact by a frightening 86%.

So for vision plus sound, 1 + 1 does not equal 2... it equals 12! That's super-additivity at work, and that's why it's absolutely vital for any organization that's designing a space to make sure that the aural experience is congruent with the visual.

What do we mean by congruent?

For spaces where spoken communication is the primary purpose (for example conference rooms, class rooms, courtrooms, lecture halls and auditoria), congruence means a combination of excellent speech intelligibility and the naturalness that only comes with high quality sound, with the desirable outcome that people don't have to strain to hear.

For spaces where other activities are primary (such as shops, hotels, stadia and transport facilities), congruence means creating an overall soundscape that supports what people are trying to do and is appropriate for the brand, the environment and the type of people in the space.

+

=

Getting it wrong means massively undermining visual impact. Architects and interior designers please take note! Designing spaces that look great is all very well, but if they sound terrible and are unpleasant to be in then the lovely visuals are largely wasted.

Let's now look at how to design effective, appropriate sound for any space.

For vision plus sound, 1 + 1 does not equal 2... it equals 12!

Tips & traps

Transportation

Transport environments pose tough challenges. Concrete, metal and glass and the sheer size of these spaces often create poor acoustics; noise levels vary hugely as occupancy rises and falls and as loud vehicles come and go; and the public address system is likely to be in virtually constant use. Intelligibility is everything. Passengers get stressed and irritated if they can't hear important announcements, and of course life safety is primary, and usually a legal requirement: in an emergency the sound system must be intelligible or the result can be literally disastrous. With modern knowhow and equipment, it is inexcusable to have people missing trains or planes (with all the emotional and economic cost that may entail) just because they couldn't hear the announcements.

TIPS

√ Look for solutions that use well-placed mics with ANC to sense ambient noise level and maintain constant headroom of signal over noise.

√ Plan zones to localize sound appropriately; for example, boarding announcements should be audible only at the relevant gate.

√ Budget to use lots of transducers, ideally low down and close to people, in order to deliver direct signals without reflections.

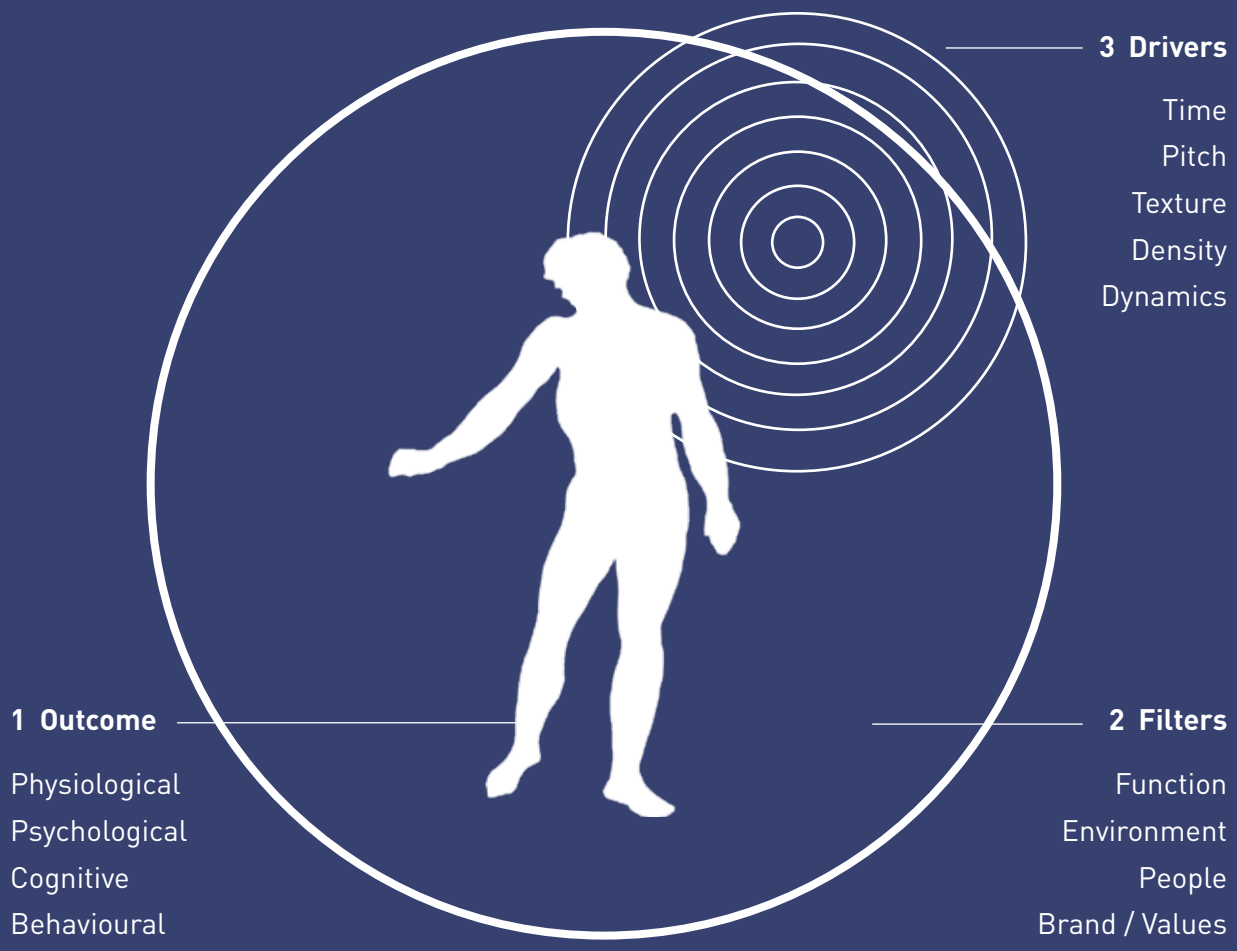
√ Make sure your suppliers are very familiar with all the current life safety codes and standards for your country.

TRAPS

× Failing to include effective telemetry back from the amplifiers in order to give clear warnings when components fail: eyeballing and walking about simply don't work in these big spaces.

× Forgetting to install mics in the main spaces to allow headphone monitoring by your staff in the control room for quick and easy health checks, for example to spot feedback.

Thanks to Mark Rogers (Greenbusch Group, USA) and Gary Nagle (Dobil Laboratories, USA)



In order to design a soundscape, we must first define the outcomes we want, then the filters specific to this situation, then we can define the sound that's going to achieve our goals given those filters.

How to design a soundscape

Although the task may at first seem very complex, The Sound Agency's SoundFlow™ model gives us a clear structure for this process. In order to design a soundscape, we must first define the outcomes we want, then the filters specific to this situation, then we can define the sound that's going to achieve our goals given those filters.

The outcomes are physiological, psychological, cognitive and behavioral. For example, we might aim to create a state that's body relaxed, feeling positive and open, cognitively clear, and inclined to stay in the space.

Then we consider the filters: function (what are people trying to achieve in the space); environment (ambient noise, acoustics and sound system); people (what do they like or dislike); and brand or values (you should be able to close your eyes in every branded space and know where you are). Most of these filters will be given, vital to understand when designing with sound but beyond our control.

However sometimes we can optimize the environmental aspects; some suggestions as to how to do this will follow later.

Finally we derive all the building blocks of sound: its pace (do we want to speed people up or slow them down?); its frequency range (higher frequencies and harmonics tend to create alertness, low frequencies tend to numb); its texture (the waveform and feel of the sound, or in the case of music the genres and artists); its density (high-density sound like music especially with vocals calls for our attention, whereas low-density sound like stochastic birdsong, ambient-style music or even repetitive trance music is easily set aside and doesn't hog mental bandwidth) and finally its dynamics (the louder relative to ambient sound, the more impactful; the greater the variation in volume, the more dense and demanding the soundscape will be).

Tips & traps

Retail

In the fast-moving world of retail, it's easy to focus solely on visual appearance and thus to undervalue sound. However, research shows that the right retail soundscape can increase sales by 38%!
A great retail sound system will meet the challenge of combining appropriate looks with great quality and even sound coverage throughout the space.

TIPS

√ Design for flexibility, creating as many zones as possible so that you can customize soundscapes for demographics and respond as the store layout inevitably changes through time.

√ Make sure your suppliers are using different types of loudspeakers for different jobs; this may require the creation of technical zones for areas with particular ceiling heights so that gains can be set and even, consistent coverage maintained.

√ Budget for ANC to respond to ambient noise variations. If that's not possible for some reason, give a small number of authorized people easy access to the system for volume changes.

√ Use loudspeakers that blend in with the visual design and pick locations sensitively so that the system adds to, rather than subtracts from, the overall look.

√ Insist on listening tests so you can choose a system that your senior management can be confident will deliver sound that matches the brand values.

√ Use enough loudspeakers to achieve even, high quality coverage.

TRAPS

× Accepting any solution based on one big zone.

× Allowing your architect or designer to create a space that's acoustically uncomfortable (for example all reflective surfaces, with reverberation time of a second or more): this will simply reduce dwell time and therefore lose sales.

× Delegating sound system selection to your technical people who may have no stake in customer experience or brand expression.

× Forgetting to employ an acoustics specialist to model the space.

× Putting cost at the top of the purchase criteria. Compared to the rest of the fit-out, sound is low cost but high impact.

× Playing the same music as everyone else. Instead, employ a specialist to express your unique brand sound in music or soundscapes so that people could close their eyes and know where they are.

Thanks to Ken O'Byrne (LSIS, Hong Kong)

Creating the right environment

Noise

Many retailers can transform a shop's soundscape simply by closing its door to street noise (research shows that, contrary to received wisdom, this has absolutely no negative effect on sales). For any commercial space, always specify maximum noise output when ordering equipment like HVAC, chiller cabinets and IT: we recommend 40 dB at one meter as a default. Squeaks, hums and buzzes resulting from broken or badly-configured equipment should be spotted and promptly fixed. Every space, from a corporate HQ to a shopping mall, stadium or station, should have someone senior with the added role of sound manager, touring the space to listen regularly against a checklist in order to maintain an optimal soundscape.

Acoustics

Inappropriate acoustics can be fixed, or at least greatly improved, with simple treatments: it's always worth having a checkup from an acoustician, and every design project should involve one at an early stage. The most important aspect of any space is reverberation time (RT). As a rule of thumb where speech intelligibility is important, RT should be under one second, and parallel walls should be avoided or broken up with non-reflective fittings. This is absolutely vital in meeting and meeting rooms, where miscommunication is simply unacceptable. A good conference room, especially one with an audio conferencing system, needs proper sound insulation from outside and good, clear acoustics. This usually means plenty of absorbent surfaces, such as carpet, acoustic ceiling tiles and curtains, and may require special sound absorbers or diffusers.
The value of good acoustics in any communication space is enormous.

Once we've controlled noise and optimized acoustics, we can install a sound system.

Always design spaces for experience, not just appearance.

Tips & traps

Healthcare

The stakes are high for sound in healthcare, especially in hospitals. For years, function has driven architecture and design, and scant attention has been paid to the auditory experience. The sad outcome is a combination of challenging acoustics and multiple unpleasant noise sources. Stand in an intensive care room and listen to the hisses, beeps and buzzes and wonder how people get well (or work) in such a negative soundscape. Improving this is going to be a long haul. Sound systems can make the situation better, not worse, by focusing on quality to deliver excellent intelligibility in spoken communication, because poor intelligibility creates stress, conflict and misunderstandings – which in these places can be life-threatening.

TIPS

√ Optimize room acoustics as far as possible, working with an acoustician; then, optimize the system for the acoustics you are left with.

√ Ensure the supplier does a thorough needs assessment with you to ensure they completely meet your needs and expectations.

√ Eliminate all the electromechanical noise you can; then ensure that your audio system is adapted to deliver in spite of any that remains.

√ Plan for high use and low support: systems must be theft and vandal proof, and simple enough to be managed and maintained by your (non-technical) staff, which may mean compromises have to be made.

√ Create highly targeted zoning for the paging system, using ANC to minimize volume levels, and integrate nurse call.

TRAPS

× Forgetting to insist that your solution includes Acoustic Echo Cancellation* (AEC) and audio-mixing for any audio/video conferencing systems.

× Settling for table-top speakerphones in large rooms – they simply don't deliver because distant people can't hear or be heard.

× Choosing a too-rigid solution: these environments change, so the system must be adaptable.

Thanks to Ben Shemuel (Teecom, USA)

The sound system

Always get the best sound system you can afford, matching its quality to the quality standards of the brand or other set of values behind the space, and also to the intended outcomes. I have lost count of the times I have been shocked by appalling sound in high-quality branded spaces like luxury shops or high class hotels or restaurants. Sometimes this is due to the low priority given to sound: someone technical with no brand experience has been given the job of choosing the sound system and they've gone for cheap, low-end loudspeakers and amplifiers to save money. Sometimes the system is broken or badly set (for example equalization completely askew because someone bumped into the controls) – and nobody has noticed. Sometimes it's because the system is mis-specified or badly installed, creating hotspots, voids or overspills with competing sound sources clashing.

Often, there is a further problem with the content itself being poor quality (typically over-compressed, either digitally or aurally, or both).

There are three essential requirements for an effective sound system.

Consistency

The sound experience should be consistent in quality and quantity everywhere in the space. If you have varying ceiling heights or acoustics, this can present a real challenge. Get a professional to do some acoustic modeling so that the right speakers can be set at the right levels to make sure you don't have hotspots and voids. Install enough speakers to achieve even coverage. Use ANC to track ambient sound levels automatically, so that staff don't have to keep changing the volume (or forgetting to!).

Quality

Set your bar high. Involve senior people with an interest in brand experience in testing different systems until you find one that reflects the values you hold and that creates the customer experience you want. Remember those hidden yet important harmonics: high quality sound contains many more of them, so it communicates better, can be set at lower levels and is more comfortable to be in.

If you have challenging acoustics (for example in a stadium or a rail terminus) use the latest speaker technology and acoustic treatments to reduce echoes. There are loudspeakers now for every possible

There are three essential requirements for an effective sound system...

purpose, from highly directional (creating pools or beams of sound) to surface transducers and panels that turn whole walls, ceilings or windows into loudspeakers.
With this many tools in our bag, there is no excuse for delivering a poor audio experience today, even in the most demanding spaces. Where possible, use high sensitivity* loudspeakers as they need less powerful and thus less expensive amplifiers.

Flexibility

Create the smallest zones you can so that you can recombine them in different configurations as your space changes. Build in the ability to inject a mic or line signal simply in every zone for announcements, speeches, parties or any requirement you can't foresee right now. Go digital to make your system future-proof and flexible. With features like internet-based control of scheduling and routing for multiple sources and delivery points; wifi control pads that allow in situ tweaks of volume, equalization (EQ) and content; and sophisticated DSP such as ANC and AEC to give you full control and the best results throughout the system. There are also no knobs to be bumped or twiddled, preventing many problems!

A word on content

Of course, any system is only as good as its weakest link. Content quality is important too: putting 64 kbps mp3 music through a great sound system is unjustifiable today with the cost of storage so low and still falling. Use the least compression your network bandwidth will permit, with bitrates ideally always above 192 kbps stereo (96 kbps mono). Severe data compression is a very common mistake, removing the richness and information content of sound. Most important of all, use experts when deciding what to play, whether it's a music playlist or a generative soundscape. Remember: sound affects people, so beware of choosing pop music just because someone on the team likes it!

...consistency, quality and flexibility.

Tips & traps

Courtrooms

These are possibly the most demanding audio installations around, partly because of the multiple sources and the need for universal intelligibility, and partly because of the high cost of bad sound in human terms. Quality sound is critical in courtrooms because it increases comfort and reduces stress – vital when people can be in these spaces, often under great duress, for hours at a stretch. A court is all about verbal communication, so excellent speech intelligibility is fundamental: straining to hear someone creates unnecessary extra anxiety. This is theatre in the round, where everyone in the space must be able to hear everyone else. Acoustics are variable, which is why system design is key: a good system can to some degree compensate for a poor space, while a bad system in a good space doesn't work.

TIPS

√ Take a holistic approach to design.

√ Set the clear goal of recreating natural conversational sound, despite the large distances between people. Nobody should feel they have to raise their voice to be heard.

√ Specify that the frequency response at the listener's ear should be 120 Hz – 12 kHz (within 2 dB).

√ Ask to have beam steered array loudspeakers and top class auto-mixers* included in your options: they can make a quantum difference to the level of gain you can achieve before feedback sets in.

√ Ensure the auto-mixer you are being offered can distinguish between wanted and unwanted speech.

√ Be sure to stipulate if recording may be required, in which case your system may need to balance live and recorded sound requirements. Rifle-type mics may be ideal for optimising live sound, but if people turn their heads away from such mics, their voices can simply disappear from a recording.

TRAPS

× Thinking this is easy: it isn't!

× Using a mix-minus (aka clean feed) system: they can lead to a judge at one end of a bench not being able to hear what a colleague at the other end is saying.

× Using only ceiling loudspeakers: they can create a disconnect between the visual source and the aural leading to what Canadian sound author Murray Schafer calls schizophonia. This can produce discomfort and make comprehension more difficult.

× Over-amplifying – though equally bad is under-powering.

Thanks to Rod Louey-Gung (Telepresence World, Australia) and Glenn Leembruggen (Acoustic Directions, Australia)

Glossary of terms used

This glossary of terms will help you to understand some of the technical terms used by audio professionals. This will enable you to better understand the solutions that they propose and to judge whether they are right for you.

Acoustic Echo Cancellation (AEC) – a DSP algorithm that removes unwanted echoes in video and teleconferencing applications.

Ambient Noise Compensation (ANC) – a DSP algorithm that maintains a constant headroom over ambient noise levels, sometimes termed autogain.

Audio Video Bridging (AVB) – a set of standards developed by a task group of the IEEE 802.1 committee for the purpose of transmitting low latency time-synchronized audio and video data over layer 2 networks.

Auto-mixer – an audio processor (or algorithm within a DSP) which turns mics on and off automatically as people speak. This allows mics which are not being used and are only picking up ambient noise to be turned off, and so improves intelligibility.

CobraNet – a proprietary (owned by Cirrus Logic) layer 2 Ethernet protocol for transmitting time-synchronized audio data.

Decibel (dB) – a logarithmic scale that measures Sound Pressure Level* (SPL) (among other things), with 0 dB being roughly equivalent to the threshold of human hearing. As human hearing is not flat across frequencies, weighting scales are often applied to compensate. Throughout this book, 'dB' refers to A-weighted dB, usually written dBA.

Digital signal processor (DSP) – an 'audio computer' containing algorithms that alter digital sound, for example to filter, delay, mix or route it, or to add or remove artifacts such as echo or feedback.

Hertz (Hz) – a unit of frequency or oscillation in cycles per second. From 1,000 Hz up we use kilohertz (kHz).

Line array – a group of loudspeakers ('drivers') arranged in a line. Placement and or processing of the drivers increases directivity control, reducing reflections and reverberation and so improving intelligibility.

NC35 – This refers to the Noise Criterion curve value of 35. These curves are used to determine what the acceptable noise level is for

a given space. As a point of reference, NC20 to 25 curves are used for theaters and performing art centers, while NC45 to 55 are used for places such as kitchens, laundry facilities or computer equipment rooms.

Needed Acoustic Gain (NAG) – the NAG equation is used to determine how much gain (in dB) is required by the sound system so the acoustic level at the farthest listening position equates to that at the nearest listening position without a sound system.

Point source cluster – a group of loudspeakers positioned and processed to cover a wide area while giving the audience the impression that the sound is coming from a single point.

Polarity – simply connecting positive to positive and negative to negative. Doing this the wrong way around can create phase cancellation effects and ruin sound.

Potential Acoustic Gain (PAG) – the PAG equation is used to determine how much gain (in dB) is available before the system reaches the point of feedback.

Reverberation time (RT) – in each case in this book we mean RT60, which is the time it takes for the sound in a space to decay by 60 dB below the SPL of the original sound. An RT of less than one second is fairly 'dry', while huge reverberant spaces like cathedrals can have RT of up to 10 seconds.

Sensitivity (in loudspeakers) – a measure of how efficient the speaker is at turning electrical energy into sound. It's usually expressed as x dB with 2.83 V @ 1 m, in other words the SPL measured at one meter directly in front of the speaker with 1 watt of input (which for a typical 8 ohm speaker is 2.83 volts). An increase of 3 dB in this rating means you will need half as much power to achieve the same SPL – though see below about the difference between SPL and perceived loudness.

Sound pressure level (SPL) – a measure of sound amplitude, rather than its perceived volume. SPL is measured in dB, and a general guideline is that an increase of 10 dB is perceived as a doubling of loudness.

Thanks to

Julian Treasure, with his great passion for sound and the knowledge to back up this passion. He does great work through his company, The Sound Agency, and I highly recommend him to anyone needing advice about using sound, especially in branding.

Salomé Galjaard and Anna Witteman are equally as passionate about their own world of data visualization and design, and I cannot recommend their company, Imaginary Numbers, too highly to anyone requiring these services.

Biamp Systems share this passion – in our case, for making truly great audio processing equipment. I would like to thank everyone at Biamp who has participated in this project, especially Steve Metzger, Matt Czyzewski and Stacy Butchart. More importantly, I'd like to thank Biamp for having the vision to embrace this project and their magnanimity in offering it as a gift to the industry that we love.

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Graeme Harrison,
November 2011

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Notes

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