

# CHOOSING THE RIGHT SOUND SYSTEM.





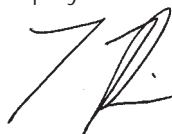
# SOUND SYSTEM DOESN'T HAVE TO BE DIFFICULT.

If you've ever been responsible for choosing a sound system for a public building, you know the importance of clear, intelligible sound. And you're probably familiar with the pitfalls, too. The role that room geometry plays. How construction materials can affect the sound. The impact of reverberation. All the things that can turn a renovation or new construction job into a difficult and frustrating process.

Whether this is your first installation, or you're an experienced veteran, we've prepared this guide to give you tips and pointers that can help you avoid common mistakes – saving you time, money and frustration. It can give you a good idea of what to look for in a sound system. How to recognize quality sound. And how to go about planning a system that meets your needs and your budget.

This guide won't make you a pro by any means. But in a few short minutes, it can give you the information you need to make sensible, informed decisions. And you won't need a degree in acoustics to do it.

I hope you find the information useful.

A handwritten signature in black ink, appearing to read 'Tony Price', with a stylized flourish at the end.

Tony Price,  
Director, Professional Systems  
Bose Corporation

## GOOD SOUND IS GOOD SENSE

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A good sound system is a genuine “business” decision – even for organizations that aren’t traditional businesses. For retailers, good sound can create a mood conducive to buying or dining. At houses of worship, studies show a good sound system has a significant impact on attendance. And at sports arenas, it can add clarity to the play-by-play announcements, and excitement to the game. The point is, choosing a sound system is an important decision that will have significant effects on your business or organization. That’s why it pays dividends to “do the homework” – so you get quality sound with no surprises during the design and installation process.

### **Get off to a fast start with a feasibility study.**

When architects begin a new construction project or a renovation, they generally perform a series of feasibility studies to determine the practicality of the building’s overall design. They may evaluate the site plan for its influence on pedestrian traffic flow. Or for its impact on the environment. Such studies save time, money and embarrassment by helping ensure that the plans will actually work.

The same is true of an acoustic feasibility study. It helps ensure that plans affecting a sound system are realistic. That a proposed sound system is the most appropriate solution for the space and intended use. And finally, that the system will come in on budget. In short, an acoustic feasibility study is inexpensive insurance against budget-breaking mistakes and disappointing sound quality.

Your sound designer can prepare a simple feasibility study that can help you:

- \* Evaluate blueprints (or the existing space) for potential acoustic problems, such as unfavorable geometry or building materials.

- \* Determine if the sound system is appropriate for its intended use. Can it provide a clear sermon as well as deep bass and high soprano for the choir? Can it deliver good play-by-play announcements as well as full bandwidth halftime music?
- \* Anticipate future changes. For example, will sky boxes be added at a later date? Will you be taking your new sound system to a larger facility in a few years?
- \* Select the location of speakers to ensure performance, compliance with building codes, and minimal interference with sight lines.
- \* Check for the impact of HVAC noise or other noise that might interfere with sound quality.

**Speech intelligibility. The bigger the space, the bigger the challenge.**

The ability to understand speech is something most people take for granted. But delivering a human voice in a large building so everyone can understand it can be quite complicated – a real challenge for even the most experienced sound designer.

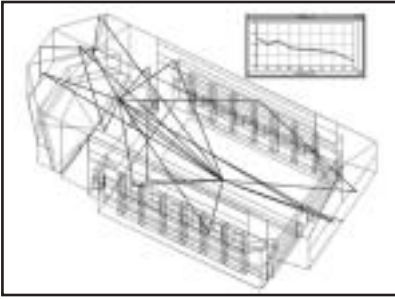
“Speech intelligibility” is the yardstick that the sound industry uses to determine the accuracy with which words will be transmitted from speaker to listener. In a small, quiet room, speech intelligibility is likely to be nearly 100%. That is, every word uttered will be heard and understood.

But move to a larger public space – a house of worship or an airport, for instance – and the complications begin to mount. Reverberation, vocal distortion, dead spots and background noise all work against intelligibility, and that can cause people to miss important information.

## Factors that affect intelligibility.

### Reverberation.

Reverberation occurs when sound bounces back and forth off hard surfaces. The materials used for walls and ceilings – as well as the geometric shape of the space itself – all affect reverberation.



A certain amount of reverberation is actually helpful, enriching voice and music alike. But too much reverberation – particularly reverberation that lasts too long – creates a multitude of echoes that ruin intelligibility.

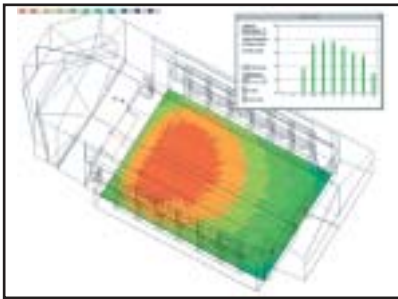
*When sound bounces off hard surfaces, the reflections can be strong enough to cause reverberation, making music sound muddy and speech unintelligible.*

Reverberation gets more troublesome as the distance increases between the listener and the source. So, the larger the space, the greater the chance for reverberation problems.

Reverberation can best be controlled by careful planning of materials and surfaces in the early stages of architectural development.

### Tonal balance.

Tonal balance refers to the relative loudness of the various frequencies being reproduced. Music and speech that's tonally balanced – or equalized – will sound natural, while poor tonal balance generally gives an unnatural, muffled, shrill or harsh quality to speech and music. Speech may be loud enough, but it loses intelligibility. Poor tonal balance



*The tonal balance of any room – represented here by the bar graph in the upper right corner – can vary widely from spot to spot, making it difficult for some listeners to understand speech.*

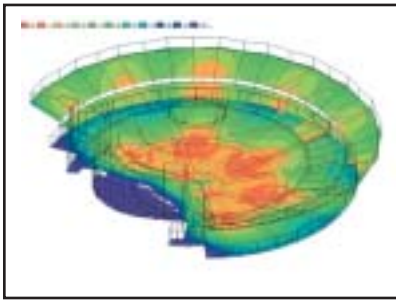
is usually the result of improper speaker placement or a poor quality sound system. An analysis of room acoustics and speaker placement by your sound designer, along with the use of a good quality sound system, will help ensure adequate tonal balance for good speech intelligibility.

### **Distortion.**

When a sound system improperly reproduces a particular frequency it's called distortion. Distortion can alter the human voice, resulting in a raspy, broken, buzzy quality that makes a person sound as if he or she is talking on a radio with a weak signal. Distortion is the result of a poor sound system, and can easily be avoided by specifying a quality system.

### **Dead spots.**

Dead spots are areas in which sound is so seriously reduced as to be unintelligible. Dead spots are generally caused by the misplacement of speakers, and can be eliminated with a thorough acoustical analysis of the geometry of the space and speaker placement.



*Dead spots, shown here in purple and blue, can be difficult to predict without an acoustical analysis.*

### **Noise.**

In sports facilities the crowd roar after a play can overpower the public address announcer or music, making them unintelligible. In other kinds of facilities, other

intermittent noises – like the roar of an airplane, train, air conditioner or even a standing ovation – can temporarily drown out the sound system. Noise is rarely a problem, however, since sound engineers can set loudness levels high enough to overcome all but the noisiest moments.

### **Human factors.**

It's worth noting that an individual's poor articulation or improper handling of a microphone can result in intelligibility problems even when the sound system and acoustics of the space are perfectly fine. For example, speaking too close to a microphone can exaggerate "plosives" – words that begin with sounds like "p" and "t" – creating popping sounds that drown out the remainder of the word. The remedy is to select a high-quality microphone and make sure presenters practice with it.



**The risk of waiting until construction is complete.**

A sound system for even a modest house of worship can cost thousands of dollars. For a large sports arena, expenses can easily top \$2 million or more. To avoid costly mistakes, it's only natural that anyone responsible for new construction or renovations would want some kind of assurance about sound quality.

For most aspects of construction, professionals and clients alike can look at specifications, examine samples of materials, and get a pretty good idea of what they are paying for. Unfortunately, until now there were no such assurances when designing a sound system. With so many variables contributing to acoustic quality, testing could only take place when construction was nearly complete. In short, sound quality could not be predicted, often leading to anomalies that required expensive alterations to correct.

**The Bose® Auditorer® audio demonstration system.  
The technology to hear before you buy.**

To help designers and installers avoid expensive mistakes, Bose Corporation began researching ways to predict the acoustics of buildings in 1985. This led to the development of our Modeler® software, which uses architectural plans to build a sophisticated acoustic model of any proposed or existing space. With the data provided by this technology, sound professionals could answer important questions like "Will the entire audience area be covered evenly with sound? Will the maximum sound level be sufficient? Will there be any reflections that might lead to echoes?" The Modeler software proved remarkably accurate and useful, a reliable tool that has helped sound designers improve intelligibility while eliminating many of the costly changes that can break a budget.

The next step was an even greater challenge – a demonstration that allowed designers, engineers and clients to actually “hear” the finished product. Bose® engineers spent nine years researching and refining a software program that uses the Modeler® software data to modify sound and create an audio demonstration that accurately predicts the way speech and music will sound in any building. The result is Bose Corporation’s proprietary Auditor® demonstration system – a combination of hardware and software that can preview sound quality from any location in any building. So if a parishioner in Pew 8 can’t understand the sermon, or a passenger at Gate 10 can’t hear a flight announcement, the engineer can modify the design while it’s still in the computer. Design changes can easily be checked and rechecked until optimal sound quality is achieved. And it all happens long before a single component is installed – or even before the building exists.

*When Germany’s new Bundestag building, home to the German Parliament, was completed in Bonn in 1992, its opening was delayed because of major sound problems. The acoustics were so poor that speeches were unintelligible, requiring a multi-million dollar acoustic retrofit before the building could be used. These problems were not the result of incompetence or carelessness. There was simply no way of predicting how the design would function acoustically until construction was complete.*

## What you hear is what you get.

Before the development of the Modeler<sup>®</sup> design program, designers and clients had to wait until “opening day” to test the intelligibility of the system. Testing occurred using one of two conventional methods – both of which were complex and expensive to carry out.

The first method, subject-based testing, uses human subjects listening to words through the sound system. Speech intelligibility is then scored based on responses.

Because the test involves human subjects and literally thousands of words and seating positions, these tests are very expensive and difficult to administer. That explains why they're rarely used.

The second method – which has been adopted as the industry standard – is called the STI or Speech Transmission Index. The STI predicts intelligibility by playing a test signal

through the system into the room, and then measuring the results with a computer. The process takes about 15 minutes for each listening location, and requires an acoustical expert. These people are hard to find, and expensive to hire, so even this method has been used reluctantly. Yet, despite the difficulty and expense of confirming a building's STI, local building codes are beginning to require public spaces to meet specific STI requirements in order to qualify for an occupancy permit.

Recognizing a growing need for a simple, reliable testing procedure, the creators of the STI method worked in close collaboration with Bose<sup>®</sup> engineers to develop a portable measuring device for fast, accurate STI measurements. This meter has gained popularity throughout the industry because it allows a technician or installer – or even a lay person – to take measurements in about 15 seconds per seat. So now, with Bose technologies,



your installer can confirm that your sound system will meet your expectations.

The Modeler® design program – the only tool on the market today that actually predicts STI – helps ensure compliance with any building codes, while saving you the cost of expensive architectural rework.

The Auditorer® demonstration program lets you hear what the system will actually sound like in your building long before it's ever installed. In actual trials, the sound quality predicted by the Auditorer demonstration system has consistently correlated with both conventional testing methods, as well as with the new STI meter. Studies show that listeners can barely distinguish between sound from a real system, and sound generated by the corresponding Auditorer demonstration model. Finally, a quick check with the new STI meter confirms the results.

Using Bose technologies, you don't have to understand complicated engineering principles to be involved in the decision-making process. Speaker choices, speaker placement, acoustic materials and other design variables can all be experienced and compared in advance. People can hear the result of various design modifications with their own ears, and make informed decisions with confidence.



In fact, Bose is so confident of our technologies that we can guarantee that the sound quality of the finished installation will be at least as good as that heard with the Auditorer demonstration system.

### First Baptist Church, Sevierville, Tennessee

About to embark on a major expansion that would triple the size of their sanctuary to seat 2000, the First Baptist Church building committee was looking for a solution that would meet the varied needs of their musically-accomplished congregation. People in the Sevierville area know good sound. Just a few hours from Nashville, the building committee had visited many of the performance centers and theaters to learn what they could about sound system installation. At each location, they found that some form of modification had been required during or after construction. Eager to avoid such added expenses, they looked to Bose® for a turnkey solution. The Auditorer® demonstration program allowed them to listen to the sanctuary as it would sound with different ceiling and wall treatments.



Scott Andrews, Minister of Music, describes his experience, “When I listened to the demonstration I was really enthusiastic. But I wanted to know if the sanctuary was actually going to sound like that. Bose told us that if we didn’t think the sound was every bit as good, they’d do whatever it takes to make it right.” Andrews got his first chance to hear the results during installation, when the system was still being fine-tuned. “Tears came to my eyes. I was overwhelmed with emotion at how wonderful it sounded.”

### GM Place, Vancouver, BC

General Motors Place is a 22,000 seat arena in Vancouver, British Columbia – home of the Vancouver Canucks of the NHL. Using Auditorer demonstration technology, General Motors Place executives were able to hear the acoustics – and fine tune the system – before the arena was ever built.



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The results were both accurate and impressive. Press reviews described the arena's acoustics as "symphony-like" and "first of its kind – loud, clear and true." Tom Anselmi, then vice president and general manager of General Motors Place remembers the first Canucks game in the new arena: "The sound system was being played to entertain the crowd, and after the music stopped, the crowd rose to their feet and applauded – for the sound. The sound system received a standing ovation."

Everyone connected with the project was justifiably proud, but not surprised. The sound they heard after installation was the same sound they heard during the playing of the Auditorer® demonstration system before construction.

### **Mariucci Arena, University of Minnesota**

The officials responsible for Mariucci Arena, the University of Minnesota's \$20-million, ultramodern hockey facility, decided against an acoustic treatment during construction. They feared the treatment would muffle crowd noise generated by the avid Minnesota fans, which provided a definite home-ice advantage.

However, the results were disastrous. When the arena opened, university officials were roundly criticized for building a state-of-the-art facility in which you couldn't even hear the announcer. They turned to Bose® for help. The Bose engineers proceeded to accomplish what was considered impossible – improving speech intelligibility while maintaining the impact of high-decibel crowd noise.

Using Auditorer demonstration technology as part of an acoustic feasibility study, the engineers demonstrated to university officials what was possible with a new Bose sound system while remaining within budget.

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The Bose® team took officials on a “preview tour” of their arena, allowing them to sample the sound at many locations – without ever leaving the office. Bose guaranteed the end results would match the sound of the Auditor® demonstration program or the company would remove the new sound system and there would be no cost to the university.

The officials accepted the no-risk deal. The first live performance of the Star Spangled Banner at a hockey game brought goose bumps to listeners. University officials were quite impressed that quality sound could so greatly improve the entertainment value of their facility.

As Scott Ellison, the program manager for Mariucci Arena noted: “The sound was splendid throughout the arena, and not just for announcements. A brief violin selection and a few numbers from a jazz band sounded as though they were performed in a more intimate setting than a 20,000-seat arena. All of the other experts said flat out it couldn’t be done.”





## Escalating demands.

**N**ot long ago, the best sound quality originated from analog recordings on vinyl albums. Today, everything's digital – and better for it.

What's more, with the improved sound quality of modern home theater systems and car stereo systems, people have become accustomed to quality sound – studies confirm that three out of four people can easily recognize good quality sound from poor quality sound, and prefer it. The tinny- or flat-sounding music and speech that was once tolerated, is now considered annoying.

The point is, facilities managers must contend with escalating demands. Arenas, for instance, are multi-use structures that host conventions, trade shows, expositions and concerts in addition to sporting events. And while quality sound is important at a hockey or basketball game, it's absolutely critical to other applications. Garbled speech during a presentation isn't likely to impress someone looking to book a convention.

Knowing all this, the first question you might logically ask is this: "Do I need to upgrade?" Your ears can answer that question best. Just listen:

- Can you clearly understand announcements, even with audience or congregation noise?
- Can you clearly hear announcements throughout the facility, or are there localized areas with distortion, poor tonal balance, reverberation or echoes?
- Are there dead spots where the sound is muffled or little sound is heard?
- Does the human voice sound natural?
- Can you listen to music and clearly hear the lowest and highest notes?

- Does music sound full and rich?
- When you close your eyes, do you hear a lifelike “soundstage”, with the musicians arranged from left to right in front of you?
- Does the music sound natural? Spacious? Lifelike?

If you answered “no” to any of these questions, then your ears are telling you that it’s probably time for an upgrade.

### **What if it’s not the sound system?**

Some acoustical problems in medium-to-large venues – houses of worship, auditoriums, arenas and stadiums – are caused by factors other than the sound system alone. In these cases, an acoustic treatment such as wall paneling or ceiling baffles may be necessary. A carefully designed sound system – either by itself or installed in conjunction with acoustic treatments – can solve problems that may seem insurmountable.

### **How do you know what quality of sound to expect?**

The only way to judge the quality of a new sound system is to listen. The same holds true for the acoustic impact of any other design change.

Before Auditorer® demonstration technology was available, you could only hear a demonstration of your sound system after construction was complete. But by then, it was too late. Even small changes can require expensive fixes.

Using the Auditorer demonstration system early in the design process can save money in costly design changes later on. And you don’t need to be an engineer or architect to determine the level of sound quality you need. Just open your ears and listen.

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**The Bose® Auditor® demonstration system can help you:**

- ✓ Experience the sound system – as it will sound in your building – before any installation takes place.
- ✓ Avoid costly and embarrassing mistakes.
- ✓ Experience the level of sound quality you're paying for.
- ✓ Experiment with the effects architectural design modifications may have on the sound.
- ✓ Compare the effects of acoustical treatments.
- ✓ Get the best value for your sound system investment.
- ✓ *Receive the Bose 100% satisfaction guarantee that assures sound in the finished space will meet or exceed the quality of sound produced by the Auditor demonstration system.*



As one of the primary design elements of your space, sound quality should not be an afterthought during construction or renovation. If it is, you're much more likely to have difficulties.

## **First things first.**

First and foremost, make sure your sound designer and architect are on a first-name basis before planning begins. When the designer and architect team up right from the start, you're much more likely to get the best possible sound from your budget.

In fact, if you don't involve the sound designer early on, you're opening the door for a number of problems. For example, without proper input, prime locations for loudspeakers may be filled by other elements. The architect may specify materials for the walls and ceilings that hinder good sound quality. Sometimes, small adjustments in the geometry of the space can make a world of difference in sound quality – but your architect may not know that without input from the sound designer. In short, the earlier the sound designer is involved, the better your chances of avoiding costly mistakes and acoustical flaws.

## **Find a good sound engineer.**

The best way to ensure that you have a good sound engineer is to verify references. Check with recent clients your designer has worked for, and ask to see a work history on jobs similar to yours. Furthermore, be sure your sound engineer guarantees high-quality sound in the room.

## **I want it to sound like that.**

You wouldn't buy a car without driving it. Don't buy a sound system without listening to it. But before you start listening, think about the quality of sound you need

both now and in the future. Will a choir be singing through your sound system? Will there be loud crowd noises from sporting events vying with public address announcements? Will your facility host trade shows and conventions, where you'll need good speech intelligibility and accurate reproduction of the human voice?

Visit facilities similar to yours and listen – and thoroughly share your expectations with your sound designer. Be sure they understand the degree of sound quality you want.

### **Run the numbers.**

All design elements compete for dollars during construction or renovation, but don't be too quick to scrimp on sound. Assess the value of sound quality to your venue and your audience before you decide what you can or can't afford.

It's possible that a small incremental investment in a better sound system will pay big dividends in sound quality. And remember, it will always be much more expensive to correct mistakes later than to invest in the appropriate level of sound quality right from the start.

### **Compare systems.**

Once you decide on the level of sound quality you want, there are other things to consider. For example, you'll need to ensure the sound system meets local building codes for safety. Sound systems must meet standards for structural integrity, fire safety and use of materials that won't release toxins in the event of fire.

Also, consider reliability. Is a warranty and maintenance agreement included as part of the purchase price? Another important criterion is ease of operation. Be sure the sound designer is willing to demonstrate operation of the system so your staff will understand its proper use.

## What do all these specifications mean?

Don't be overly concerned about all the acoustic figures generated by your sound designer and architect. No matter how well you understand them, numbers can't accurately predict sound. This fact has led to any number of expensive and embarrassing architectural mistakes – mistakes not caused by carelessness or incompetence, but by the intangible nature of acoustic design. And perhaps even more fundamentally, the dangers inherent in not listening to the sound quality of a system before it is actually installed. A multi-million dollar construction or renovation project is fraught with enough pitfalls. Don't let sound be one of them.

## Why take the risk?

Without Auditorer<sup>®</sup> demonstration technology, you'll never hear your sound system until it's installed. So, no matter how carefully your architect has planned, no matter how good your sound contractor is, there's always the chance you'll be disappointed with the results. By that time, it may be too late to fix even simple problems cost-effectively.

With Auditorer demonstration technology, you'll know exactly what you're getting long before installation. Which means you'll get it right the first time.



G U A R A



**The Bose® performance guarantee:  
What you hear is what you get.**

Bose Corporation will fully guarantee the sound quality of any system that is designed, demonstrated and sold using the Auditorer® demonstration system.

If the sound quality of the real system does not match the sound heard using the Auditorer demonstration system at the time the system was accepted, Bose will attempt to fix the problem. If a suitable fix cannot be found, Bose will refund the purchase price of the Bose equipment and installation, and pay for removal of the speaker system.

N T E E D .

## Checklist for good sound.

- List your requirements (speech, live music, recorded music, etc.)
- Determine your budget
- Find a good sound designer
- Introduce sound designer and architect (if using an architect)
- Visit other installations, listen and discuss with your sound designer
- Set and define expectations with sound designer
- Invite designer to attend an event in your space
- Listen to a demo in your space (live or virtual)
- Authorize sound designer to perform a site survey
- Review and accept proposal
- Oversee and approve commissioning of system
- Send staff to sound contractor for training
- Ask for service and maintenance schedule outline



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Better sound through research<sup>®</sup>

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