BINAURALIZATION™

Now You Can Hear How a Room Will Sound Before Construction Starts!

By Steven J. Thorburn, PE

How often have you wondered what, a room was going to sound like before it was built? How would it sound if the walls were parallel and not canted? Are all of the acoustical room finishes really required? Will there be echoes? Is the reverberation time too long? What will speech sound like in the room? What will music sound like?

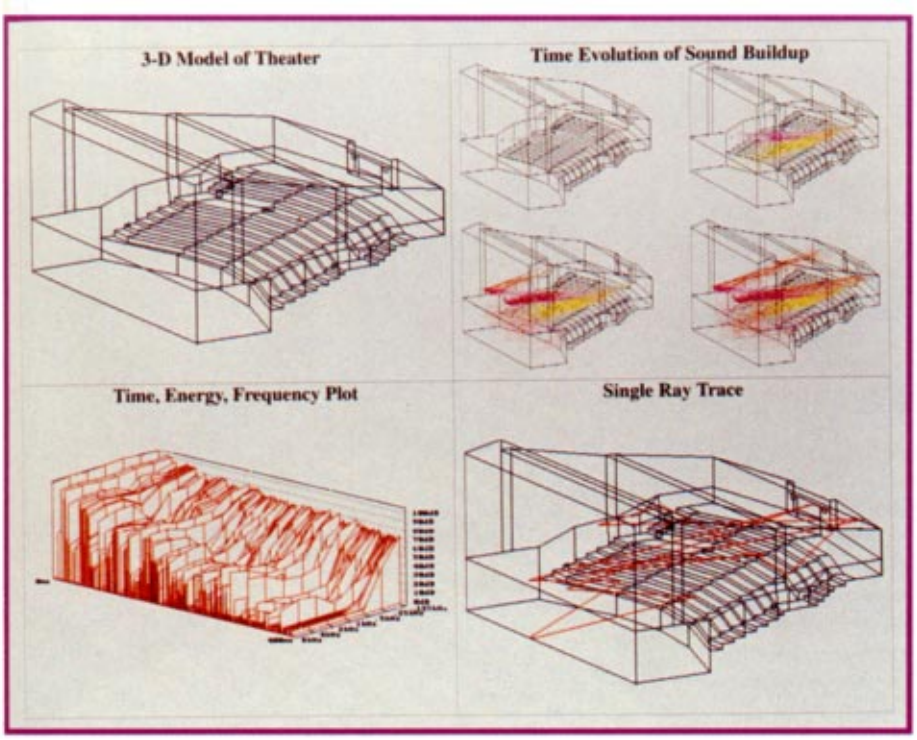

Figure A (bottom left). Complex Graphics are no longer necessary to understand the Acoustical Characteristics of a room when using Binauralizations™. Figure B (bottom right). Single Ray Tracing showing how sound is both absorbed and reflected throughout a space.

Much has been published on this subject. A major consumer loudspeaker manufacturer has developed a system to model a room with their loudspeakers. However, at Thorburn Associates, we have been working with this type of technology for more than two years; we call it Binauralization™.

Binauralizations™ (two-ear simulations) let you "hear" how a room will sound prior to its actual construction. Just as three-dimensional architectural models and computer graphic fly-throughs help us visualize and better understand how a building or room will look, Binauralizations™ enable us to hear and understand the effects of acoustical treatments. These simulations allow you to using a cost-effective process to hear how different aesthetic and finish designs will affect the acoustics of a room.

Prior to Binauralizations™, modeling was used primarily for large and extremely critical projects such as concert halls. The only way to acoustically model a space was to build a scale model of the room. This is tedious and time consuming. To build an acoustically accurate scale model, the details, the relief, and even the construction materials must be scaled down to match the appropriate acoustical ef-

Acoustical Terms: What Are They, and What Do They Mean?

Sound Transmission Class describes how much sound a wall or a floor/ceiling construction will block from one room to the next. A good analogy to an STC rating is the fire rating of a partition. A two-hour fire-rated assembly will keep the fire on the opposite side of the partition longer than a 20-minute assembly. Just like fire ratings, the higher the STC rating, the better the isolation. Therefore, an STC 50 partition will block more sound than an STC 30 partition.

Noise Reduction Coefficient defines how much sound specific materials absorb. This is analogous to a room's finishes. Just as various colors of paint, or textures, visually alter a room, various materials with different NRC ratings, such as carpet or tile, audibly alter a room. A material with a low NRC rating (tile) absorbs little sound, and a material with a higher NRC rating (carpet) absorbs more sound.

Noise Criteria measures how much mechanical noise can be heard in o room. This type of measurement can be compared to the amount of light in a room. A foot candle describes how much illumination a lighting fixture provides on a surface, NC describes how much mechanical system noise is heard in a room. The brighter the light on a surface, the higher the foot candles, and the higher the NC rating, the more noise that is heard.

Are STC, NRC and NC related? Not really. They do interact in the total design of a room, just as the building structure, room finishes and lighting interacts on the visual design of a space. Individually, however, they all play separate roles. Room finishes are independent of the fire rating of the partition, just as the amount of sound a material absorbs is independent of its ability to block sound from one room to the next.

fects. Because the sound waves that we hear range from 56 feet to two-thirds of an inch in length, it is difftcult to find materials that accurately scale down to 1/10-inch or 1/4-inch scale models.

Unlike model building for visual aesthetics (where a red barn looks like a red barn) we can't just paint the surfaces to create the same scaled visual look. We must also scale the acoustical characteristics of the materials used. Computer simulations allow us to address the problems of the scale in a much more effective manner.

Also, unlike scale models, where complex charts and numbers are used to represent the acoustical properties of

the room (See Figure A, page 37), Binauralizations™ let you hear for yourself if the finished project will sound good or bad.

Some of the questions that always arise when we discuss this new technology with clients are “How accurate is the model?” “Can we adequately rely on what we hear in the computer simulation to reflect what will actually be built?” and “How can we use this new technology to better serve our clients?”

Does It Work?

Prior to offering Binauralization™ as a service, we modeled a number of different spaces, then conducted binaural measurements once construction or retrofitting was completed. What we found is that while it is very difficult to achieve an exact model of the room, the major issues that we, as acoustical consultants, are concerned with and need to communicate to the owners and architects, are very readily apparent. So, yes, it does work!

After the model is built, we can readily change surface materials to allow you to hear just how bad an echo will be if we don’t treat the walls or determine if you need to have an acoustical tile ceiling, prior to construction.

The first step in developing an acoustical simulation is identifying the finishes within the room, both in type and location. Once the physical characteristics of the model are defined, random rays are sent out from a source location (See Figure B, page 37). These rays simulate sound waves leaving the source and traveling in the room. As the rays hit a surface, the computer determines how much acoustical energy is absorbed by that surface, how much energy is reflected, and in what direction.

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Sound, *continued from page 41*

This process continues until the sound ray has traveled a predetermined length of time. The longer we let the calculation go, the more accurate the model. Accuracy is also increased with the number of rays sent out.

with this information in hand, we then post-process audio from a compact disc or tape or a recording of your own voice, and let you listen to that sound from a specific location in the mom.

How Can I Use Binauralizations™?

After the model is built, we can readily change surface materials to allow you to hear just how bad an echo will be if we don't treat the walls or determine if you need to have an acoustical tile ceiling, prior to construction. Binauralizations™ allow the client to make a subjective decision without relying on us to "verbalize" our recommendations in a meeting or with a report.

The sound waves we hear range from 56 feet to two-thirds of an inch in length.

We can model any type of facility from churches to theaters to conference rooms to lobbies to casinos to entire theme-parks! Binauralizations™ are for any project where good acoustics are necessary and bad acoustics can ruin its success!

About the Author

Steven J. Thorbum, PE, is a principal with Thorburn Associates, Inc., an acoustical consulting and audiovisual system engineering firm with offices in Northern and Southern California. He is chairman of the Design Consultants Council for the International Communications Industry Association, and is active in the design and development, of projects around the world.