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ARENA AND STADIUM SOUND REINFORCEMENT SYSTEMS

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MAIN SOUND REINFORCEMENT SYSTEM

Like many other situations, there is no one "right" answer for a sound system loudspeaker configuration. There are a number of approaches which merit consideration and each of these approaches has its own strengths and weaknesses.

In recent years, professional sports have come to rely on arena and stadium sound systems to provide far more than simple voice only announcements. Most North American sports franchises currently make extensive use of prerecorded and live popular music to entertain their customers. The presence of a large video display screen and the desire of the facility manager to host an expanded schedule of non-sporting events demands that the sound system be capable of a level of quality that is representative of other entertainment mediums, particularly home video and television.

The function of the Main Sound Reinforcement System is to provide high quality speech and music to both the fixed and moveable spectator seating. Due to the specialized nature of high powered pop and rock concerts, it is not recommended to accommodate these events with the house sound system. They are best served by transient touring or rental sound systems.

There are four basic configurations for introducing sound to spectator seating. The traditional approach is to suspend a single central cluster in the building center of an arena or at the end zone or outfield end of a stadium. This configuration works well for sports events, but can present problems when the end stage mode is used. In many stadiums and arenas, the end stage mode is rarely used by a program or act that does not intend to use it's own touring system, including major political conventions and evangelists. For these facilities it is not cost effective to provide dedicated equipment for the end stage mode. Regardless of what loudspeaker configuration is chosen, a fundamental decision that must be made is whether or not the building management requires the regular use of the house system in the end stage configuration. Although some facilities have dedicated auxillary clusters or even moveable loudspeakers for the end stage mode, our observation has been that they are used on an infrequent basis. This, of course is not true for some college facilities, where end stage presentations and convocations are a regular occurrence.

The delivery of intelligible speech and good quality music is always a complex task in any multi-use facility. The variety of events requires a system that is flexible and reliable. This requirement has given rise to several configurations for delivering sound to the seats.

ARENA AND STADIUM SOUND REINFORCEMENT SYSTEMS

CENTRAL CLUSTER

The central cluster system is the most common form of loudspeaker arrangement for arenas. The advantages include having all sound originate from a single location and the ability to utilize large arrays of loudspeakers to provide sufficient sound levels to overcome noisy crowds. By keeping the loudspeakers in one tight group, the problems with echoes from multiple speaker locations arriving at different times are minimized. The central cluster can provide good coverage to the court area if there is nothing below it (such as a scoreboard) to block the sound.

The major disadvantage of the cluster system is that they are physically large and heavy. Another potential problem with the cluster is the possible acoustical shadowing at the front rows of fixed seating by the hockey dasher board glass, and at the court side seats in basketball, from a center hung scoreboard. The exact amount of shadowing will depend on the specific mounting height of the cluster and the proximity of the seats to the dasher board. For end stage events, the centrally mounted cluster would be inappropriate, although it is possible to mount the speaker system on a track and physically move the cluster to the end stage position. The costs associated with the relocation equipment are usually as expensive as providing a dedicated end stage cluster; therefore, the moveable central cluster is rarely utilized.

Even with the speaker cluster, there will be times when it is appropriate to use rental or "touring" type sound systems. Most musical groups will insist on using only their own equipment and do not want to utilize the "house" system. Other events that might require special systems will include presentations with exceptional needs such as very high loudness capability (115 dBA) or extreme low frequency reproduction. Also, certain staging locations (such as a side stage position, along the long side of an arena) may necessitate a rental system.

One of the biggest operational problems with a central cluster is that the concentric mounting of the cluster and scoreboard necessarily ties their operational heights to a limited range. This is due to the fact that the cluster is designed to work at a fixed height due the aiming of individual loudspeaker devices at specific seating areas. Raising or lowering the cluster a significant amount destroys this careful aiming. If the scoreboard is raised to accommodate a special production utilizing the house sound system, it may block, or shadow lower level and floor seating, resulting in poor sound quality and marginal, at best, intelligibility. Central clusters also may have general intelligibility problems in highly reverberant rooms as the loudspeaker to listener distance is large, allowing the reverberant sound built up in the facility to interfere with the sound coming directly from the cluster. This is quantified by direct to reverberant sound level calculations. To provide quality sound, the direct sound must always be louder than the reverberant sound, when a room is very live, this is difficult to accomplish as the sound reflecting from room surfaces is not reduced to a significant degree, making it virtually as loud as the sound coming directly from the loudspeaker source. An example of this acoustical effect is often found in cathedral style churches and racquetball/squash courts.

The central cluster is usually the most cost effective system, where appropriate, as its loudspeaker parts count and rigging and equipment costs are lower.

EXPLODED CLUSTER

This loudspeaker configuration concept separates, or "explodes" the central cluster into what are typically four to six clusters, or pods, one on each side of a center hung scoreboard. These clusters are located in plan just outside the perimeter of the scoreboard. This configuration is used at the Palace of Auburn Hills and the new Minneapolis NBA arena. Its advantages over the single center cluster are that the loudspeakers are more physically separated from the scoreboard, allowing a greater range of relative motion between the two without affecting the operation of either. This range is still necessarily limited due to sightline considerations. For example, if the scoreboard is raised a significant amount, the loudspeakers (now lower in relation to the scoreboard) may block the view of the scoreboard. This arrangement makes it easy to raise the scoreboard completely out of the way for events using the sound system only. It also prevents shadowing from the scoreboard to floor and court side seats. Another advantage is that the average speaker to listener distance is shorter than for the central cluster. A two cluster variation of this scheme is used in the Calgary Saddledome due to its unique roof design which is too low in the center to allow the use of a central cluster.

The costs of the exploded cluster are higher than for the central cluster due to the need for additional structure and winching to support and move four or six clusters rather than a single cluster.

SATELLITE CLUSTERS

This arrangement places several (typically seven to fifteen) small clusters in a ring, or concentric rings throughout a stadium or arena. The Charlotte Coliseum and most domed stadiums employ this approach. The satellite clusters are usually located just below the roof structural system. This concept is often employed when there is not sufficient room or clearance for more centrally located loudspeakers. This may be due to a low ceiling height which would cause speakers to block sightlines, or in the case of Charlotte, a combination of low structure and a large scoreboard which consumes the vast majority of the central volume. In domed stadia, the satellite approach is used to place the loudspeaker closer to the listeners, in what has often been a highly reverberant environment. While generally resulting in improved sound, this is not as important in indoor arenas where the loudspeaker throw distances are much shorter. If the diameter of a loudspeaker ring is large enough, the shadowing from the hockey dasher board glass is completely eliminated.

If an appropriate loudspeaker layout and signal processing are used the satellite system can support both hockey and basketball and endstage events well. The disadvantages of this concept are cost, due to the increased numbers of loudspeakers and components and their

support and installation. There can also be architectural implications as the loudspeakers must hang low enough to be appropriately close to the seating. This typically means loudspeaker to listener distances of less than 70 feet to realize a significant acoustical advantage over a single central cluster.

DISTRIBUTED SPEAKERS

The use of distributed speakers for the indoor arena is a relatively new approach that suspends small loudspeakers (4-6 cubic foot enclosures) at numerous locations, in a regular grid, throughout the spectator seating area. The sound systems at McNichols Arena in Denver and Arco Arena in Sacramento are typical of this approach. By placing the speakers closer to the listeners, each speaker system does not have to work as hard to provide the same sound level to the spectators. This feature also permits a different type of speaker to be used since the throw distances from the speaker to the listener are reduced to about one-third the normal distance, as compared with a central cluster. The result is that a more natural speech quality can be achieved through the use of multiple speaker positions (20-30 total locations).

Another advantage of distributed speakers is that there is no large mass of speakers in the center of the building; thereby, reducing the structural loading on the building and possibly simplifying the design and installation of the scoreboard.

A disadvantage of distributed systems is that they may not provide good coverage to the court or playing floor area. While this is not a significant problem with sporting events, it is a problem for staged events such as conventions and rallies where spectators will be seated in that area. Also, the normal arrangement for the distributed speakers assumes the action takes place in the center of the room; for end stage arrangements using the house system, the distributed speaker approach may cause the sound to appear to originate from a location other than the stage if extensive switching and processing equipment is not employed. The large quantity of loudspeakers used means that there may be seating without clear views to small portions of the arena, especially directly across to the other side. Sitelines to the scoreboard signage and floor are usually not obscured. Most of the obscured views will be of the ceiling or other spectators, but there will be some locations where segments of end mounted scoreboards may be blocked.

The cost of the distributed system is typically the highest of the four configurations, due to its increased equipment cost. In many cases, such as Denver, with its low ceiling, it was chosen due to the geometry of the arena. In Sacramento it was used as the Panasonic equipment purchased was best suited for this application.

COSTS

Any of these speaker system arrangements can provide acceptably good, high quality (though not identical) sound to all areas of a stadium or arena. The decision as to which approach to use can depend more on operational considerations than on acoustical decisions. Hanging numerous loudspeakers around a stadium or arena has a definite visual impact, but frees up the space over center court where the central cluster normally resides. The cluster may minimize the visual impact but requires a costly winching system to raise and the system and may also limit some of the scoreboard's flexibility. Costs for equivalent audio quality can be similar for any of the four systems, ranging from $200,000 (U.S. Dollars) for a minimal to $600,000 (U.S. Dollars) for the speakers and amplifiers for the main seating bowl alone, exclusive of conduit and AC power requirements. As a point of reference recent projects with the various types of configurations have ranged in cost as follows:

1. Central Cluster - $350,000 (U.S. Dollars)
2. Exploded Cluster - $600,000 (U.S. Dollars)
3. Satellite Clusters - $800,000 (U.S. Dollars)
4. Distributed System - $1.2 million (U.S. Dollars)

These costs are for a building's entire audio systems, including concourses, suites etc., which are different in each situation. For this reason these costs should be considered as representative of what other recent facilities have expended on their sound systems rather than a strict comparison of the various approaches. These costs do not include conduit costs.

CONCLUSION

As you can see, there are no clear cut, easy answers to choosing a sound reinforcement system, however there are four viable alternatives from which to choose. Each stadium and arena is unique in design and purpose and it is the responsibility of a trained professional to choose and design an appropriate sound reinforcement system.

As sports fans and event goers increase in number and sophistication, technology continues to advance the state-of-the-art in facility planning and design. Sound reinforcement systems are certainly a vital element of any modern stadium or arena.