

Frazier Application Note

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Gymnasium Sound

Background

High school gymnasiums have always been problematic for the sound system designer/installer. High crowd noise levels, highly reflective room surfaces, and limited sound system budgets make the design of an effective sound system for a typical gymnasium a real challenge. Additional complication is introduced when the facility will also be used for assemblies, graduation exercises, plays, and the like.

Judicious use of Frazier products in the design of a gymnasium/auditorium sound system will yield a performance/price ratio that cannot be approached with competitive products. The information contained in this application note will assist the conscientious designer/installer in making the best choices for a given application.

"Gimmick" and Generic Products

A number of loudspeakers on the market are represented by their manufacturers as providing easy solutions to the difficult electroacoustic problems outlined above. These products fit into two broad categories: preassembled "arrays" of individual two-way subsystems, and loudspeakers with spheroidal housings. In spite of the claims made for these devices, neither type is very effective at overcoming the real problems encountered in gymnasium environments.

The first approach - prefab arrays with 360 degree horizontal coverage - fails to offer a real solution for a number of reasons:

1. The required horizontal coverage in a high school gym is usually much less than 360 degrees. More often than not, seating is restricted to the long sides of the basketball court. In these situations, devices aimed at either end of the room only serve to increase reverberant energy. This leads to poor intelligibility and lack of definition.
2. Without exception, competitive prefab arrays utilize *direct radiators* for low frequencies (below 2.5-3 kHz). Whatever useful directional control such systems may have resides well above the 2 kHz octave band, the most critical one for speech intelligibility. At lower frequencies, these devices are completely uncontrolled in their directivity, indiscriminately spraying sound energy everywhere. In addition to generating too much reverberant energy for acceptable intelligibility, this arrangement will create an objectionable degree of comb filtering due to interference between neighboring low frequency radiators.
3. Prefab arrays have their horns installed at a fixed vertical angle. In any given situation, this predetermined down angle is very unlikely to be the correct one for best coverage and minimal reverberation.
4. The SPL required to fully overcome crowd noise at basketball games and other sports events is generally not achievable with a centrally-located prefab array.
5. The non-coincident nature of low and high frequency elements in competitive prefab arrays guarantees that notches in the frequency response around the crossover frequency due to non-synchronized signal arrivals will be present in a large percentage of the seating.
6. The ideal location for a central array for basketball games is a poor choice when other uses of the facility are contemplated.

The second type of "cure-all" - a spheroidal-shaped contraption - is an even less credible candidate for a high school gym system. The reasons:

1. The nature of the direct field response of these devices is very ragged. This characteristic alone renders them unsuitable for any sound system in which intelligibility or naturalness of sound are important criteria.
2. The vertical angle of maximum acoustic output is just below horizontal. If one observes the manufacturer's recommendation and flush-mounts the device to the ceiling, far more acoustic energy will be scattered among the rafters than will be directed at the audience.
3. There is no horizontal directivity whatever. See previous section.

The Genuine Article

In contrast to the above gimmickry, Frazier loudspeakers offer legitimate, cost-effective long-term solutions to the problems associated with gymnasium sound systems. A well designed and properly installed sound system utilizing Frazier products will provide satisfying results for years to come, at a cost that often doesn't exceed that of installing one of the "gimmick" products. Keep in mind that truly effective solutions to engineering problems of the sort we are discussing here always require careful advance planning. In the real world, one size never really fits all, and it is ultimately up to the "tailor" (the contractor/specifier) to determine the best "fit" of loudspeakers and other sound system equipment to a given facility. After all, that's what your customer is paying you to do. The following information will provide general guidance to help you in your Frazier sound system design work.

Acoustic Performance Criteria

Crowd noise in a medium size high school gymnasium can easily reach 90 dBA or more during the course of a sporting event. The "rule of thumb" for minimum signal/noise (10 dB) would imply that a sound system should be capable of continuous operation at 100 dBA in audience areas. This constitutes a reasonable initial target, although, as we will see, this may not always be achievable.

Reverberant energy is another problem area. A direct/reverberant ratio of 6 dB or more will result in acceptable intelligibility. This requirement has significant implications for the type of sound system design.

Multi-use facilities pose additional challenges. When the facility is used for an assembly, graduation exercises, or a stage production, greater coverage than that necessary for bleachers alone will usually be necessary. Additionally, the optimum locations for loudspeakers will be different: e.g., a central cluster will be required at one end, rather than in the center, of the facility. To help balance these additional demands, the required SPL for non-sporting uses of a gymnasium facility will typically be no greater than 80-85 dB.

The required bandwidth for acceptable performance will also vary depending on the use of the facility. For announcements at sporting events, it is best to minimize low frequency bandwidth. A lower cutoff frequency somewhere between 100-200 Hz, depending on the type of sound system, is best for this use. On the other hand, other uses of the facility may call for the ability to reproduce or reinforce deeper bass frequencies a lower cutoff frequency of 40-60 Hz is more appropriate for this type of use. These apparently conflicting demands must be resolved if the customer is to be satisfied with the finished system.

Central Clusters

Central clusters in a highly reverberant, noisy environment such as a high school gymnasium must meet very stringent demands on individual device directivity and acoustic output capacity. If an honest and thorough evaluation is performed, it will often become evident that a properly done central cluster is simply beyond the budget available to the school for a gym sound system.

In cases where the budget is sufficient to accommodate a central array, the Frazier CAT 50 product family will yield better sound performance than any competitive devices. The advantages:

1. Superior directivity control - the Frazier CAT 56 (60 x 40) and CAT 59 (90 x 40) are horn-loaded over their entire bandwidths and produce their nominal directivity from 600 Hz upwards. This is in contrast with competitive products that typically have no pattern control below 1500 Hz.
2. Unequaled transient response - Coincident Aligned Transducers technology, developed by Frazier, creates a loudspeaker that preserves the waveform shape of very complex signals such as speech. This quality guarantees the best possible intelligibility and the most transparent sound with music.
3. High maximum output capacity - The CAT 56 and CAT 59 will both produce peaks of more than 136 dB at one meter. To achieve this output capacity in competitive products, you'll have to spend at least twice as much. And you still won't get Frazier's sound quality or directivity.

When added low frequency bandwidth is required, the F2520 low frequency system is the perfect complement to an array of CAT 56s and/or CAT 59s.

Distributed Systems

The Frazier CAT 40 and CAT 40 HS are far and away the best loudspeakers for distributed systems available to the industry. Consider the following advantages of the CAT 40 over every competitive option:

1. Horn loading for *both* low and high frequencies. The typical 12" coax ceiling speaker has no useful directivity characteristics below the crossover frequency (usually 1500-2000 Hz), whereas the CAT 40's pattern control extends downward to 650 Hz, with very little rearward radiation even in the 500 Hz octave band (350-700 Hz). This is of inestimable value in a gymnasium. The uncontrolled low frequency radiation of the CAT 40's competitors will create significant intelligibility problems in reverberant spaces.
2. The CAT 40 has its transducers placed at the optimal locations for synchronized signal arrivals. The combination of proper physical relationships, crossovers that introduce no phase or amplitude errors to the system response, correct polarities for LF and HF elements, and matched directivities, results in sonic transparency that is not approached in alternative units. In addition to sounding more natural, the CAT 40 and CAT 40 HS will always yield superior intelligibility.
3. Assembly to completion *at the factory*. We build CAT 40s, so you can focus on building sound systems. We can equip your CAT 40s with transformers, metal grilles (hidden by the standard cloth grille), standard *or custom* suspension fasteners, and ceiling baffles as you require. The result is a loudspeaker your installers remove from the box, suspend, and connect. Real plug and play, and only from Frazier.
4. Production Quality Assurance: Frazier, alone among professional loudspeaker manufacturers, tests every sound reinforcement loudspeaker we make with our TEF spectrum analyzer. Every unit we ship has been verified via direct testing of the finished loudspeaker to meet or exceed its published specifications. Try to get our competitors to give you the same guarantee, and you'll see just how unique Frazier is in this industry.

When all the relevant factors are taken into account, it is readily apparent that Frazier offers the best and most complete set of loudspeaker solutions to gymnasium sound system problems.