Designing for School K-12 Multipurpose Gyms

TOA Canada Corporation

WHITE PAPER

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White Paper: TOA Canada Corporation

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Product Support and System Design

TOA Canada Corporation provides technical support for all our products. When designing a system, please do not hesitate to contact your Regional Salas Manager or our Technical Team for guidance on selection and application. TOA Canada has the software tools and expertise to provide successful solutions to your clients needs.

Product and contact information may be obtained at the following links;

WWW.TOAcanada.com
WWW.TOAcanada.com/contact/

Designing for School K-12, Multipurpose Gyms

The Purpose of Gymnasiums

Schools often employ these gym spaces for different needs, sporting events, instructional training, theatrical performance, and visual presentations to name just a few.

Designing audio systems for such a varied use can present some challenges. Not only do we have multi-use facilities, we are also faced with some very difficult room acoustics because of the hard surfaces present. Overcoming these challenges requires careful planning and selection of products to make sure that the design and usability meets the intended functions and environment challenges.

The Facility

Generally, these rooms are constructed with painted concrete block, wood floors on concrete and ceiling decks of corrugated metal. Dimensionally, a typical gym is basket ball court size of 50'W x 84'L x 25'H (15m x 25m x 7.6m). With these dimensions and surfaces, multiple reflections are a challenge to produce intelligible sound. This would be considered a "lively" room.

Rarely is acoustic treatment applied to the room and as such, careful selection of speakers and placement is required to help minimise these reflections.

Gyms may have combining requirements that will require sound systems that can manage the division and combination of the sound system.

Assemblies and productions are often a use of a gym requiring a stage. These can be portable, fixed or set into one end of a wall. The location of portable stages will often present technical issues when designing a fixed speaker location. All stages should have the main audio projecting from the stage area to the audience to create a sonic focus.

Should a gym have audience bleachers, they need to be considered when placing speakers. If additional speakers are required for the bleachers, the system designer should consider these supplementary speakers in relation to any main speaker system.

Many times consumer grade audio sources are used. These products generally have unbalanced audio outputs that must be converted into balanced audio if remotely connected to the mixer.

For more flexibility and user control, remote volume controls and source selection should be installed to control the levels of microphones and program audio sources.

Specific Requirements

The selection of product will depend on the specific needs that will be required by the use of the gym. Simple paging will not require much in the way of product however room combining and stage productions will require a more sophisticated approach and extended audio fidelity.

Most applications will require wired and wireless microphones, inputs for common audio sources such as CD, DVD and MP3 players. These inputs might be local to the equipment or remote and located on wall plates with XLR, RCA, and 3.5mm connections being common for these types of devices. As mentioned before, care must be exercised in running long unbalanced audio lines common to RCA and 3.5mm connection.

Control of inputs might be required. These can be local to the equipment or remotely located in the area of use on wall plates.

Any performance based system should consider the ability to be muted in the event of an alert from security or fire system until the emergency is terminated.

Room combining requirements allow the gym to be divided into two smaller areas. Product selected for this arrangement should have the ability to store equipment parameters into scenes so that the different room combinations can be activated (A+B combined and A , B separate). Multiple amplifier channels will be required and a simple control panel to allow for combination selection using preprogrammed scenes or memory.

Operator control for stage presentations by using a mixing console or PC based software is often a requirement.

In some cases, protection of the speakers is required by using a wire cage specifically made for this purpose.

Flying or anchoring heavy speakers to the base building will require a trained rigging expert using certified hardware suitable for this purpose. All rigging and load calculations should be approved by a certified structural engineer.

Higher end systems will generally have equipment that will require programming using a computer. Connections might employ RS-232C or TCP/IP type connections. When using these types of equipment, there can be firmware or software updates. Make sure that these products are using the latest versions supplied by TOA.

Product Classes

Microphones

Wired and wireless.

- Dynamic microphones for handheld use and condenser mics for lectern mounted mics.
- Headset mics are useful for aerobics style activities.

Mixer/Amps

Are mixers that have a built in amplifier.

- A cost effective all in one product.
- Simple user interface and tone controls.
- Higher end units may employ some DSP capabilities.
- They mostly have high impedance, 70V, 25V speaker outputs.

DSP Mixers

Mixers that have digital signal processing capabilities.

- Finer control and more extensive configuration setups are possible.
- Used mainly for performance based systems
- Require a computer to configure

Control

Remote volume and selection

- Using potentiometer,
- High impedance speaker attenuators,
- Dedicated volume with source selection devices,
- Third party solutions
- Computer control data connection using software.

DSP Processor

Digital signal processing

- Inputs and outputs.
- Speaker frequency processing, crossovers,
- Automated Acoustic Resonant Control (ARC)
- Feedback suppression (FBS)

Amplifiers

Single and multiple channels

- Analog
- Digital
- Basic rule to allow 20% amplifier power extra as headroom.
- General purpose amplifiers are high impedance from 25V to 100V.
- Performance and impact amplifiers are low impedance of 8 ohms.

Speakers

Indoor and outdoor weather resistant

- Single point source type paging horns.
- Full range, multi-frequency.
- Line array speakers.
- Generally use high impedance types of 25V to 100V with 70V being the most common and typically use 18 AWG size wiring.
- Performance and impact speakers are low impedance, 8 ohms requiring larger gauge wiring.

Product Selection Defined

Based on the requirements for a gym, several categories of product selection can be made. Although the equipment can be arranged into these specific groups, it is possible to utilize specific capabilities of product from these various groups. Also the scale of implementation will impact the fidelity and cost of the system. The suggested categories can be defines as;

Paging: Simple requirements for paging using directional horn type speakers, mixer/amplifier and base station type microphone. Generally this system would be part of the base building PA system. Normally requiring two equally spaced speakers located on the longest wall. Low fidelity for music but can be improved with speaker selection. The paging system should be separate from any other PA system employed.

Basic: Low impact. Simple user interface using the equipments controls for microphone and audio source inputs. Basic remote volume control is possible along with simple tone control. Wireless microphone system with line of site to the receiver and medium fidelity using full range single point speakers. Equipment is wall or shelf mounted and can be used for instructional guidance and low impact aerobics. Easy to install and no computer required for set up. Speakers are mounted in each half of the gym on the longest wall.

Advanced: Medium Impact. Remote control of volume and source selection is possible along with computer programming and scene recall. This system is capable of automatic filter selection called ARC, and feedback suppression. Also includes multi range speakers with processor for improved fidelity. Using line array speakers helps to control unwanted reflections and improve fidelity and speech intelligibility. Capable of room combining with scene recall, aerobics, assemblies and sports announcements. Equipment is rack mounted in an equipment room. If no line of sight to the receiver, wireless will require external antenna. More complex to install and may require speakers to be suspended from the ceiling structure. Computer maybe required.

Performance: Medium to high impact. With stage presentations and team sports being the primary functions, a system that can deliver more impact and control will be required. This system will have more user control and inputs, often with a computer control interface, multi range speaker systems for improved fidelity with improved speech intelligibility and multiple amplifier channels. Equipment is rack mounted and programmed using a computer. Installation requires a good understanding of audio and computer programmed systems. Speakers may require suspension or wall mounting.

Impact: Highest sonic impact. Suitable for performance based drama and high energy team sports. These systems will produce the highest fidelity and control to ensure excellent sonic performance and speech intelligibility. Large number of inputs required along with multiple wireless microphones. Speakers will often employ three way systems requiring multiple amplifier channels with processing. This installation will require a complete understanding of audio and computer programmed systems. Speakers may require suspension or wall mounting.

Glossary of Terms

ARC: Acoustic Resonant Control. A TOA proprietary DSP process that automatically adjusts filtering to reduce room resonance. Helps improve clarity and speech intelligibility.

FBS: Feed Back Suppression. Automated filtering dynamically inserted to help eliminate acoustic feedback when using microphones.

DSP: Digital Signal Processing will provide a set of electronic tools for modifying and controlling the audio signal. DSP may supply filters, compression, limiting, speaker processing and special functions like ARC and FBS.

AWG: American Wire Gauge. The standard used to determine the size of wiring. Typical high impedance wiring will use stranded two conductor 18 AWG wire for speaker runs.

High Impedance: A technique to drive speakers at a high voltage and low current. Helps reduce wire size over long distances. Commonly used for paging and BGM (back ground music) systems. Typically 70.7volts in North America. Amplifiers and speakers must both have this capability.

Low Impedance: Used for performance based systems with higher fidelity. Commonly of 4 and 8 ohms. Amplifiers and speakers must both have this capability.

Balanced Audio: Source audio that is split into a positive and negative signal with ground reference/shield. Used for professional applications, microphones and any audio delivered over long runs. Benefits improved signal to noise by the equipment rejecting a common interference on both the positive and negative signals.

Unbalanced Audio: Common consumer wiring for audio sources. Useful for short runs of 3-4 feet in a commercial setting, usually employed within the equipment rack. Unbalanced line runs should be converted using an active (balancing preamp) or passive (transformer) device.

Paging Speaker: Usually a horn type speaker that controls the audio energy in a controlled pattern. This controlled pattern helps to increase intelligibility by keeping unwanted reflections down. Metallic type speakers are suitable for voice paging while cone type paging speaker can produce booth speech and BGM quality audio.

Full Range Speaker: A cone type speaker that produces a wider audio spectrum than a paging horn. This type of speaker can be run from one amplifier channel and may have multiple speaker drivers in one enclosure.

Multi Frequency Speaker: These speakers are designed to pass specific bands of audio for best reproductions. Often a DSP processor is used to “steer” the correct audio signals to the appropriate speaker. Typical pass bands are; subwoofer, mid and high frequencies.

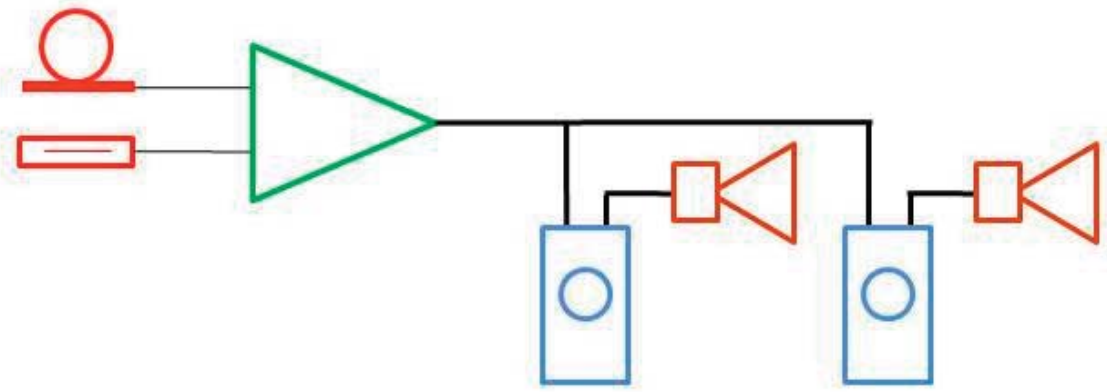
Line Arrays: By using multiple speakers aligned vertically, these speakers can focus the sound in the vertical direction. Well suited for placing sound onto the audience and reducing unwanted reflections.

Attenuator: Commonly used in high impedance speaker lines, these devices adjust volume levels in discrete steps.

Speaker Sensitivity: A specification to indicate how efficient a speaker is. Conventional speakers are measured at one **m**eter from the speaker with one **w**att of audio energy applied. The resulting measurement is listed as Sensitivity dB= 1W/1M. All sound levels are calculated using this specification. Doubling of power i*ncreases* the level by 3dB. By doubling the distance from this reference point, the level will *decrease* by 6dB.

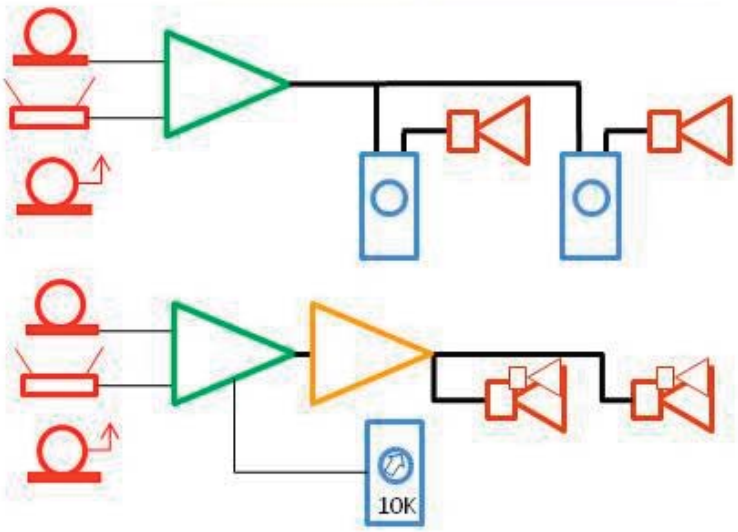
Diversity: Wireless terminology. Full diversity employs two independent receivers for continuous monitoring of signal strength available at each antenna. Space diversity uses a single receiver that switches between two antennas depending on signal strength.

Paging

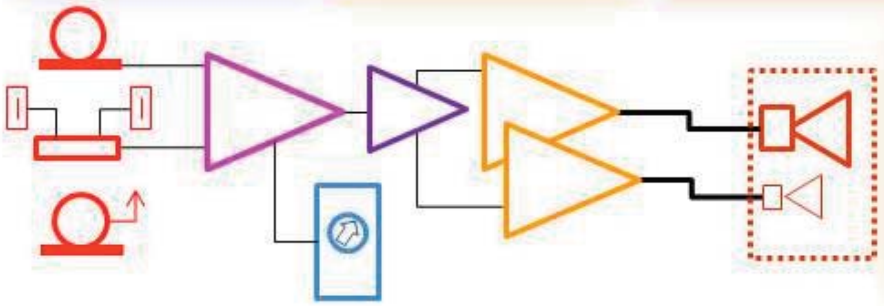


Typical system flow diagram

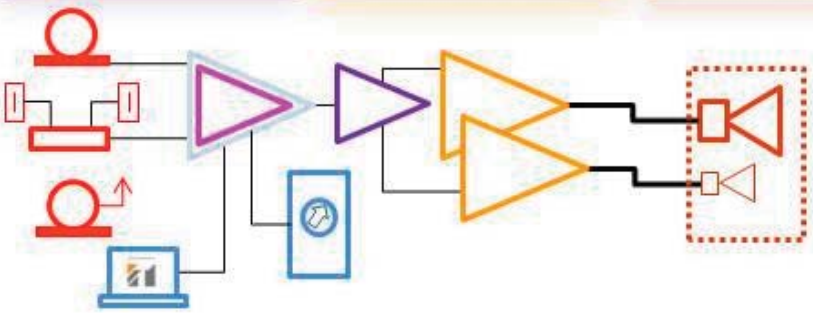
Basic



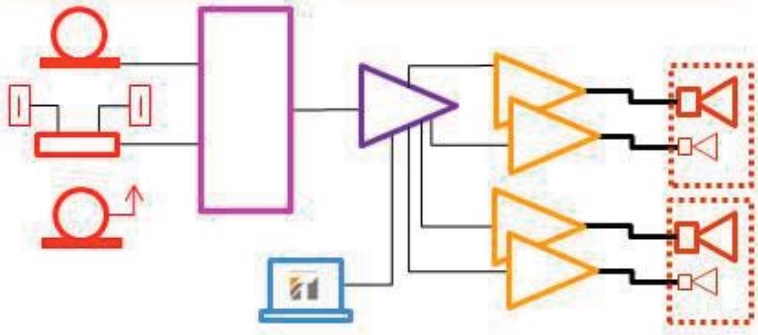
Advanced System



Performance



Impact



Sound, not equipment

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