

# OTSEGO HIGH SCHOOL OTSEGO, MICHIGAN

## PROJECT CASE STUDY



AcustiCabinets™



ACOUSTICAL TESTING PROCESS



## CHALLENGE

Improve acoustics in high school band room with in-room instrument storage.

## WENGER SOLUTION

Analyzing room characteristics before developing proper configuration of cabinets specially designed to reduce reverberation time and loudness. Installing cabinets in coordination with overall construction project.

## BENEFITS

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- Greater sound absorption and diffusion significantly enhances acoustics
- Secure, organized storage protects valuable instruments
- Cherry cabinet finish coordinates with school's interior design

## HIGHLIGHTS

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“In the planning for our new high school, I had hoped for a dedicated instrument storage room but there wasn't enough budget or space,” says Brent Morrison, Band Director at Otsego High School in Otsego, Michigan.

The previous high school had a dedicated room for instrument storage, with large homemade cabinets that held five or six instruments each. The cabinets were lined with carpet and painted blue. “They were probably handsome when new, but over the years they'd been beaten up and had become rather ugly,” he says. “They were also marking up some instrument cases.”

Morrison says he first saw the new AcoustiCabinets™ at Midwest Clinic and was pleased to learn they had been ordered for his band room.

To measure the acoustic impact of these new cabinets in a typical high school band room, Wenger Corporation took the opportunity to analyze before/after acoustical results at Otsego High School. Ron Freiheit, director of design engineering at Wenger, and a Fellow of the Acoustical Society of America, conducted the testing.

Freiheit says proper acoustics are essential in music education environments, enabling the development of critical listening skills. As one part of an overall acoustical solution, AcoustiCabinets are ideal for situations where instrument storage cabinets are located within a rehearsal room. The encapsulated acoustically absorptive material built into the back of the cabinets provides specific acoustical benefits by absorbing a broad range of sound frequencies.

“During the testing, the only change to the band room was adding the AcoustiCabinets,” explains Freiheit. They were installed on three sides of the band room, including the entire back wall, and covered approximately 14 percent of the available wall surface. Reverberation measurements were made by a real-time analyzer in seven room positions, with the data averaged. Recordings were made with a binaural system using anechoic (reflection-free) playback material.

Reverberation – or the persistence of sound in an enclosed space – affects the character and quality of music. It is measured in seconds from when the sound is generated to when it becomes inaudible. Excessive reverberance can prevent an ensemble from accurately hearing definition and detail. Articulation and timing become muddy and clarity is lost.



***“When I make a cutoff the sound doesn't ring for six or seven seconds afterwards.”***

***- Brent Morrison  
Band Director***



On-site test results in Otsego showed that the AcustiCabinets significantly decreased sound reverberation, making a better environment for music rehearsal – for both teacher and students. Independent testing data on AcustiCabinets is also available from Wenger.

After the AcustiCabinets reverberation time decreased from 3.1 seconds to 1.3 seconds. When reported as a single number, reverberation time is always given at the 500 Hz sound frequency. The resulting 3.2 dB decrease in the reflected sound energy in the room was also approximately equivalent to a 30 percent overall loudness reduction. Freiheit says the ideal reverberation time for a band/orchestra rehearsal room is considered to be between 0.8 and 1.0 seconds.

“I love the AcustiCabinets – I wish we had more,” says Morrison. “The acoustics in my band room are good – much better than my former band room. Even with my 100-piece marching band in there, the sound level is pretty comfortable. There’s not as long of a delay, which is nice. When I make a cutoff, the sound doesn’t ring for six or seven seconds afterwards. I can also hear better because the sound is getting diffused correctly.”



## Scope

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This is a summary that was conducted to document the impact an installation of Wenger AcustiCabinets has on the acoustics of a typical band room.

Most band rooms that are not designed with acoustics specifically in mind suffer from excessive loudness and extended reverberation times. The loudness becomes fatiguing and the extended reverberation times severely diminish the clarity of the sound within the rehearsal room. From Wenger's many years of experience in working with music educators and acousticians, the optimal reverberation time for a band room is in the range of 0.8 to 1.0 seconds. Times that are shorter result in rooms that may sound too "dry", longer times can start to degrade the clarity of the sound in the room. Frequently the available wall space for acoustic treatment is limited which can also negatively impact the resulting acoustics. The AcustiCabinets were developed specially with these situations in mind by integrating sound absorption into the design of the instrument storage cabinets.

## Background on Acoustical Testing

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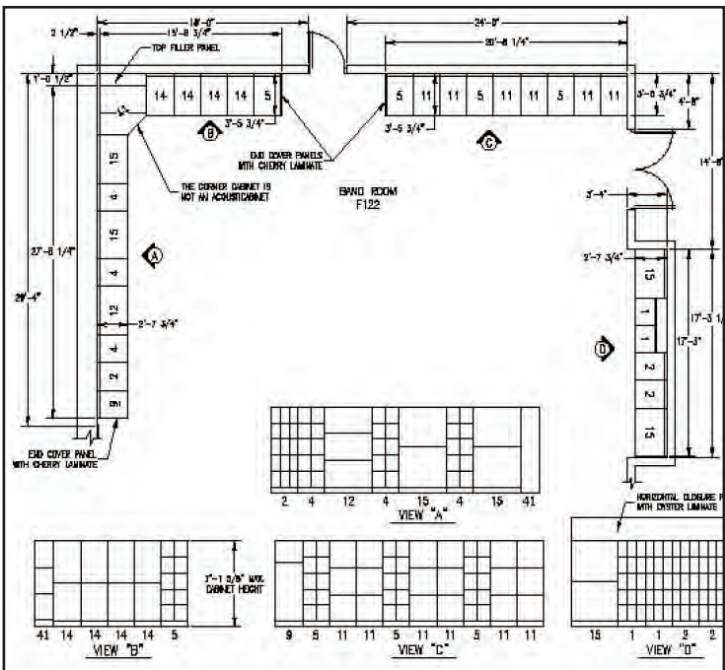
Testing was conducted at the new addition to Otsego High School in Otsego, Michigan, which included a band room. This was done while other construction was continuing around the room so noise can be heard in the audio demonstrations.

Testing was conducted in the band room on two consecutive days — May 8-9, 2007. The first day, testing was without the installation of the AcustiCabinets. The room was completed except for the electrical outlet covers being in place and doors installed in the doorways. It appeared that there might be provision for additional acoustical treatment at selected locations of the upper walls at a later date. On the second day, after the installation of the cabinets, testing was completed. The cabinets covered roughly 14% of the room's available wall surface area.

Testing was conducted with standard reverberation time measurements using a pink noise source and measuring decay time by 1/3-octave bands. Additionally, subjective testing was also conducted using a binaural head recording system, allowing for an "A" & "B" listening comparison (audio demo of the comparison is available upon request).

Reverberation measurements were made from 7 locations as indicated and the results were averaged. Background measurements were also made to ensure that adequate signal-to-noise ratios were maintained during testing.





The equipment used for reverberation measurements: Larson-Davis 2900B Real Time Analyzer, a Larson-Davis Model 2559 Random Incidence microphone capsule and Larson-Davis M900B microphone preamp. Equipment calibration utilized a Larson-Davis Model CA 250 which produces a 114 dB SPL @ 250 Hz. Source noise (pink noise) was produced using a UREI 809 speaker aimed into the corner as shown and a Crown K2 for amplification.

The binaural recordings used the same speaker and amplifier arrangement (with the speaker located in the “band area” facing the director). Calibration of the playback for the source material was 28 dB (at the amplifier output) @ 1000 Hz. An-echoic playback material was provided by following CDs: the Archimedes Project (Bang & Olufsen), Denon and the Wenger Anechoic Choral Recordings. Binaural recordings and psychoacoustic analysis were made with the HEAD System along with the associated Artemis software.

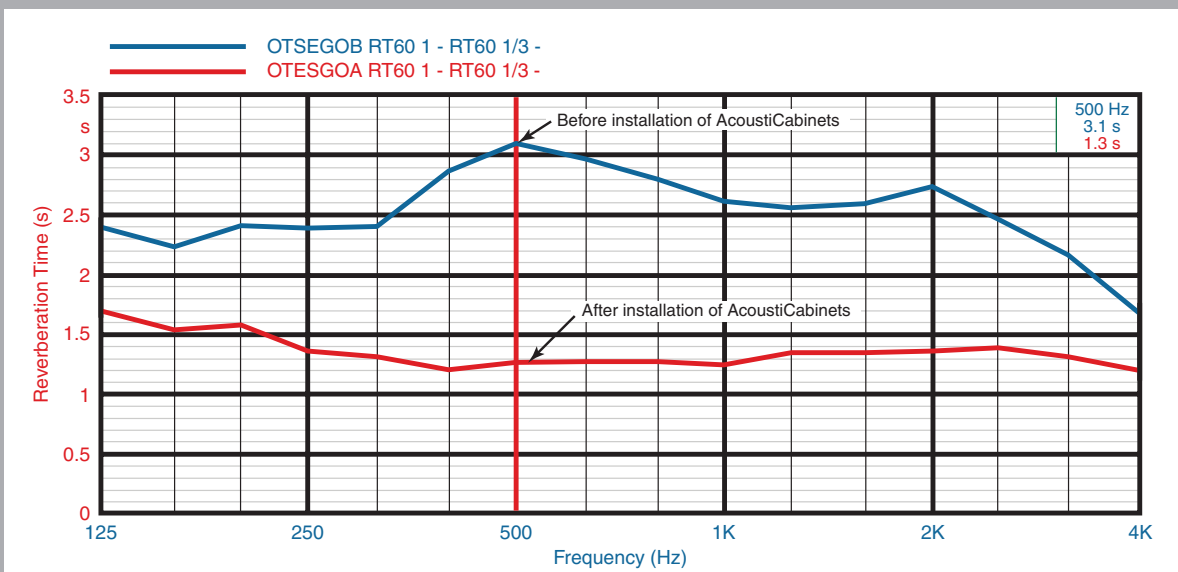
## Summary Results

The impact of the AcoustiCabinets on the acoustics of the band room showed a significant decrease in reverberation time from 3.1 seconds to 1.3 seconds at 500 Hz. (When reported as a single number, reverberation time is always given at 500 Hz.) The loudness reduction can be calculated from the reduction in reverberation time, which resulted in a 3.2 dB decrease in the reflected sound energy in the room, or an approximate 30% decrease in loudness.

Playback of the binaural recordings made with the HEAD System confirmed the significance of the reduction in reverberation time and loudness from a perceptual hearing standpoint.

An ancillary benefit of the AcoustiCabinets' compartments is the improved diffusion versus that of a flat surface. This aids in the reduction of echoes in the area the cabinets are located.

The results from the testing clearly show that further improvements to the room may be considered to lower the reverberation time to the suggested 0.8 to 1.0 second range. Additional wall and ceiling diffusion should be a consideration to minimize flutter echo near the front of the room and improve cross-communication within the group.



## REVERBERATION MEASUREMENTS

- 7 positions measured
- 7 positions averaged
- Background noise level measured
- Microphone positions:

Positions	Band Room Location		Height
Speaker	7'N	6'9"E	Floor
1	7'7"S	19'5"W	4'7"
2	15'5"N	11'8"W	4'7"
3	8'4"N	23'10"E	4'7"
4	28'4"N	28'7"E	5'7"
5	33'6"N	9'10"E	5'7"
6	21'7"N	14'6"E	5'7"
7	31'9"N	7'11"W	5'7"

## BINAURAL RECORDINGS

- Calibrated to 28 dB @ 1kHz (amplifier output)
- Pink Noise calibrated to 20 dB (amplifier output) Binaural recordings
- Anechoic recordings used:
  - Female voice (B&O CD)
  - Male voice (B&O CD)
  - Glinka (Denon CD)
  - Bruckner (Denon CD)
  - Kyrie (Wenger CD)
  - Who Am I? (Wenger CD)
- Head and speaker locations:

Positions	Band Room Location		Height
Speaker	21'11"N	14'10"E	Floor
Head - ears	23'2"S	17'5"W	42"

***On-site test results in Otsego showed that the AcoustiCabinets™ significantly decreased sound reverberation, making a better environment for music rehearsal, for both teacher and students.***





## MORE THAN 60 YEARS EXPERIENCE GUARANTEES YEARS OF SATISFACTION

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Wenger Corporation was founded in 1946 to provide innovative, high-quality products and solutions for music and theatre education, performance and athletic equipment storage and transport. We have spent more than 60 years listening to what our customers need and then designing and developing innovative, functional and durable products to meet those needs – products that enhance any program and deliver what they promise year after year.