San Rafael Church Case Study

Featuring Tectonic DML Technology and Symetrix DSP
02-28-2015

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The Problem: How to make significant coverage and intelligibility improvements in a fairly reverberant, octagonal Catholic church sanctuary. The building has seating in the round, and a system that always runs in hands-free mix mode. There were also significant mounting and aesthetic limitations,.

The Solution: Tectonic PL-12 panels were the only acceptable loudspeaker technology that could satisfied the majority of design, performance and integration challenges. A Symetrix Radius DSP engine was also a critical part of the solution; meeting the hands-free mixing requirement.

San Rafael Catholic Church, in San Diego, CA presented a unique set of sound reinforcement challenges. This octagon building has 315 degree seating, laid out in six sections of padded pews, each 10 rows deep. All other finishes are hard, smooth and reflective.

The ceiling has a gentle slope, finishing at the apex in the middle of the room, with a stained glass feature, located at the bottom of a large, octagon soffit. The eight major facets of the ceiling form a giant parabolic reflector that focuses sound on the floor, near the center of the room, where the Altar table is located.

Facility Background

Roughly three years ago the church completed an architectural remodeling that included a rebuild of the pipe organ, the organ loft façade, and new Altar and Ambo platforms. All new finishes in these areas are concrete, stone or metal. Additionally, all the carpet was removed from under and around the pews in order to liven and enhance the sound of the organ, and better support congregational singing.

The existing sound system was not upgraded at that time, thus beginning a period of several years of complaints. The quality and intelligibility of the sound was not good. The measured broadband T60 averages just under 2.0 seconds throughout this room.

Architect Bennett Lord asked me to visit the venue and discuss ideas and options for adding acoustic treatment, a new loudspeaker package, or both. However, for various reasons, the church wanted to avoid adding sound absorbing treatments if at all possible.

That initial visit raised more questions than definitive answers or ideas.

I've been in this business for a long time, and have designed several hundred sound systems. This was the first time, in memory, that I walked out of an initial site visit without a good idea what to recommend. The challenge, as it often is, was to provide full coverage and "improved" intelligibility, while meeting the client's aesthetic demands regarding what we could and couldn't do.

This project was not limited by unrealistic budgetary constraints. We had money and the client's willingness to consider just about any technological option. Steerable column arrays came to mind first. The problem is, there's no place to put a column array(s) that doesn't have a collapsing horizontal boundary over distance. Remember, this is an octagon room.

Because the pews wrap 315 degrees around the central Altar table, there was no good location to mount speakers on any vertical wall surface. Hanging six, large, high Q speakers from the ceiling soffit area could work, but the size, weight and rigging needs of such loudspeakers was unacceptable, when positioned next to the "featured" stained glass ceiling.

Aesthetics; available wire path; rigging and attachment limitations; the Altar table placed dead center on the floor; and a choir loft that occupies one of the six congregational seating segments - the list of obstacles was quite long.

The Ah-Ha Moment

The next day a possible solution came to mind. Might this be a project where DML technology would work to satisfy all the disparate challenges?

I remembered a conversation I had at Infocomm earlier in the year. I happened to stop by the Tectonic Audio Labs booth, where I had a mind-bending conversation with Dave Firestone and others. Their description of DML technology, and how it works, conflicted with all my years of training and experience. Honestly, I didn't know what to think. I left the booth thinking I would likely never use this technology. And If I were to run into an potential application, an in situ demonstration; a proof of concept would be mandatory.

Six months later the San Rafael challenge presented an excellent opportunity to put Tectonic's DML claims to a real world test. I called Marc Gonzales, from LVX Marketing, and asked about setting up a demo in the San Rafael sanctuary. The timing was nearly perfect. Tectonic had a traveling demo package that would be in Los Angeles soon, and was coming to San Diego a few days later. They were kind enough to schedule a private demo for our customer on an off-day between the LA and San Diego events.

Needless to say, the demo went well enough that both the customer and I thought this would be the answer. A cost proposal was presented and accepted, and we got started with the formal design and engineering work.

Rigging Plan

A rigging plan and structural certification were the next two important hurdles to cross. Given the geometry of the room, we determined that three Tectonic PL 12 panels would be needed to cover the 315 degree seating plan.

The structure of the octagonal room is supported by eight, large, glue-lam beams, arching from the outside walls to the central ceiling peak. Three of the beams provided the perfect alignment and attachment points for the PL 12 panels. One panel each faces East, West and South.

To keep the rigging attachment hardware as clean and simple as possible, we opted to use a video projector mounting technique, using two PDR CPM100 cathedral mounts with 1.5" threaded pipe in between. Using two CPM100s allowed us to set just about any down-tilt angle we needed.

To adapt from the PL-12 VESA mounting points to the PDR mount, we designed and made a steel adaptor plate. We also incorporated two, short, wire rope spans to meet seismic and safety requirements.

The finishing touch was a custom color match that Tectonic's provided. We painted the miscellaneous rigging hardware in our shop.

Broadband Coverage

One of the features that made the PL 12 panels ideal for this venue is it's extremely wide horizontal dispersion. While the Tectonic specs claim 165 degrees of horizontal coverage from the DML panel, and 120 degrees from the HF ribbon, our field evaluation suggest an overall rating of about 140 degrees is a little more realistic.

The PL 12 panels are bi-amped, with 5,500 Hz crossover. This means the all-important speech intelligibility range of 500-4,000 Hz is produced entirely by the DML section of the speaker.

Our project fit the 15 degree vertical dispersion footprint perfectly, because we had a high mounting position and a shallow seating plan. We were able to "paint" the HF transition edges to the back of the first row of pews and the front of the last row.

This was done by ear, using pink noise running through the HF ribbon drivers only. We had one man on the ground and another on a lift in the air, adjusting and setting the tilt angle for each panel.

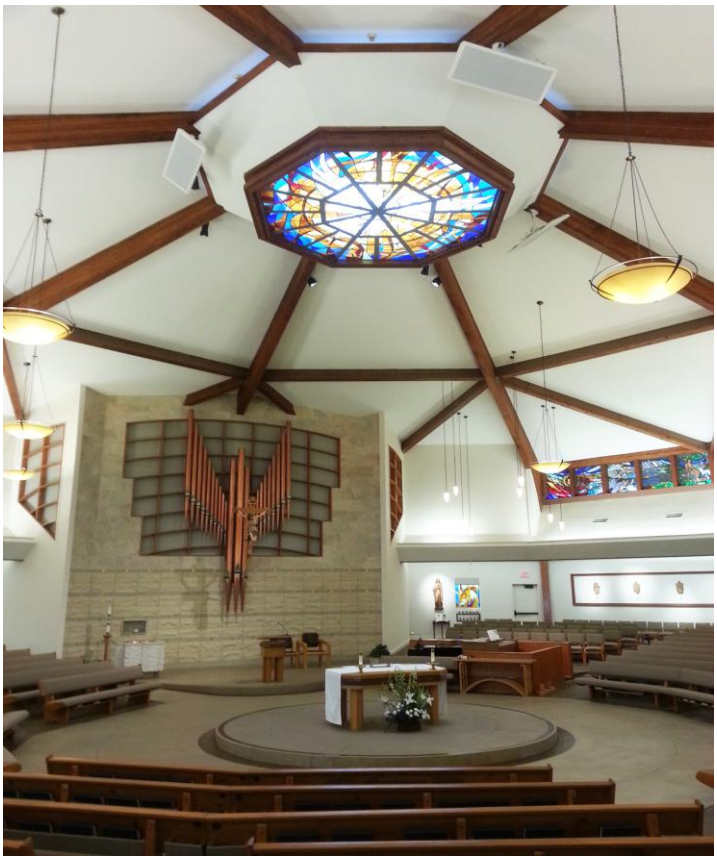
Based on our mounting opportunities, we had roughly 20’ between each panel. Two panels back to back, 10’ off the center line. We called these the East and West panels. The third panel (South) is rigged perpendicular to the other two, and is also about 10’ off the center line of the room. Each panel is about 34’ AFF, and has roughly a 55 degree down tilt.

Given this spacing and aiming, we had significant horizontal overlap between the perpendicular pairs of panels. This overlap produced an audible “thickening” of the sound in the low-mid range frequencies around 200 - 400 Hz, but there is no noticeable, mid-high comb filtering issues in the overlap zones.

Because the vertical dispersion in the DML section is pretty much the same as the horizontal, we also had a significant amount of “bottom half” vertical overlap coming off all three panels. The summation of this energy built up dead center on the floor, right where the Altar table stands.

To mitigate this, we tried a polarity flip on the South panel, but that didn’t help enough, so we went back to normal polarity. To satisfactorily resolve both the horizontal overlap thickening issue and the summing of the vertical spill, we used a few ms of delay on the South panel, and a little extra parametric EQ to thin out the low-mid region of all three panels.

Using only three DML panels, the overall coverage is amazingly even at all frequencies, throughout all 315 degrees of seating.



Commissioning

The install and commissioning process was not overly difficult. We used a Symetrix Radius 12x8 DSP, and a QSC CX 254 power amp to complete the primary signal path.

Tuning took about two hours to get things settled in with the Smaart rig, then we spent another couple of hours making minor adjustments while listening to reference tracks and live mics.

After careful tuning of the speakers and "ringing out" all mic channels, there are no feedback issues. Also, the gain sharing automixer in the Radius 12x8 helped a lot, especially when there are as many as 10, close and area mics on at the same time.

We used discrete input and output processing on every channel. Including high-pass filters, parametric EQ, and gentle compression on every input. More of the same plus crossover, delay and limiting on the output stages. This approach gave us the tools we needed to address all critical parts of the signal path.

The commissioning test rig included:

Dell Latitude - E5540 laptop, running 64bit, Windows 7 Pro
Smaart v.7 - Sound system measurement, optimization and control software
Sound Devices - USB Pre I
Lectrosonics - TM400 wireless system for test and measurement
ISEMcon - EMX-7150 reference microphone

Post Install Observations and Conclusions

Based on our first-time experience, I came away thinking the DML technology doesn't do everything that Tectonic's claims, but in comes reasonably close. Here are some comments, observations and conclusions we compiled while working on the San Rafael project.

1. The Tectonic DML technology cannot currently be modeled in any 3D modeling programs such as EASE or Modeler. However, there are some point-and-shot guidelines we can recommend. Use 140 x 140 degrees for line of sight, broadband dispersion. Use 120 x 15 degrees for HF ribbon section.

2. Vertically, the difference between the 165 DML section and the 15 degree ribbon is tricky to reconcile. Designers and users should view the PL 12 panels as having effectively 15 degree vertical coverage, while being aware that below the 5.5k crossover, the panels are putting out around 140 degrees of sound in the vertical plane. This can be in important distinction if you are trying to create acoustic "shadows" based on speaker aiming.

3. If you need more vertical coverage above the crossover, you need to use more panels. But, I wouldn't expect multiple panels to couple properly to create the type of cylindrical dispersion pattern that occurs with line array designs. So, even when multiple panels are arrayed vertically, don't expect increased throw distance based on line length.

4. DML panels are probably best used as short and mid-throw devices.

5. Don't worry too much about comb filtering, the panels don't seem to present any significant comb filtering artifacts.

6. DML panels have good, but not great power handling specs. If you need more SPL, add more panels.

7. The PL 12 panels definitely need subwoofers to extend a systems response much below 100 Hz. The San Rafael project did not require extended low frequency performance, as we were dealing with a traditional catholic church, where spoken word and choir music are the norm. Our HP filters were set to 80 Hz.

8. While the PL 12 panels sound very good, they do not present quite the mid-band, articulate clarity that can be achieved by a well-designed, compression driver and waveguide. Subjectively, I think this is because the sound "radiates" from the panels, rather than having a focused "push" of energy coming from a compression driver of some sort.

9. Tectonic's claims: "Traditional box/cone/dome systems pistonicaly push air out into the venue and create audio energy that bounces off of incidental and facing walls. The system, with its diffuse audio propagation properties, does not push a column of audio energy towards any surface. When its diffuse output does contact with a flat surface, the reflection is equally diffuse and is non destructive." This appears to be a reasonably accurate statement, but can be confusing to understand. Here's my translation.

   The DML section of the PL 12 panel sympathetically vibrates when excited by its internal drivers. The vibrating panel behaves much like the amplifying affects of a grand piano's sound board. An acoustic guitar is another example of a radiant sound, amplifying device.

10. One of the most effective tools in acoustics is diffusion. Structural diffusion geometry causes specular sound waves to be scattered in many directions, thus reducing the build-up of reverberant energy in a room. If you can imagine the DML panels producing sound that is analogous to the first array of reflections off (after striking) a really efficient diffuser panel, you should be able to imagine how it is that this technology minimizes room interactions.

11. Feedback control. Tectonic's claims: "The Tectonic system propagates diffuse audio waves that only incidentally meet the microphone; not directly into it. [Snip] The run-away effects of feedback are very difficult to initiate. [Snip] Additional anti-feedback E.Q. is not necessary."

    Our field experience suggests this to be the most overstated claim. For our application, feedback was present and quite easy to achieve. Remember, ours was a nearly round room with reflective walls, flooring, and a hard, parabolic ceiling. The DML technology did not present significantly better GBF than we would have expected from other, high-quality point source loudspeakers. "Anti-feedback" EQ was necessary, but only in small doses.

12. Intelligibility claims: 'Tectonic panels exhibit superior intelligibility for spoken word and music." Here again, our field observations suggest this to be a reasonably-true claim. Given the difficult acoustics, the PL-12 panels do produce sound with "good" intelligibility.

    Based on Smaart impulse response evaluations, typical CIS scores range from .71 to .76, depending on the seating section evaluated. Not bad for an extremely low-Q loudspeaker in a 1.8 second room.

    High-Q speakers would probably score even better. But, in order to deploy highly focused propagation around the 315 degree seating plan, the design would have required many more, and larger loudspeakers. An aesthetically, unacceptable solution.

    When only a few points are lost in AlCons or STI scores, the DML technology comes in a close second to high-Q devices. When size, weight, quantity, labor and rigging costs, and aesthetics are factored, the close second becomes an extremely viable first-consideration.

Conclusion

Now that the system has been running for about a month, the complaints have stopped, and compliments are being verbalized to the church's leadership.

The classic question is, would I specify and install Tectonic DML panels again if the application warranted them? The answer is yes, without question.