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AVSFORUM
THEATER OF THE DECADE
KEITH YATES DESIGN
Hahn Theater, Connecticut
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kyd




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INSPIRATION

By Keith Yates

My first meeting with Rob Hahn was at a little lunch place in Kentfield, just north of the Golden Gate Bridge, on February 27, 2012.

He said his motivation to build an ambitious theater came directly from his experience as a DP (Director of Photography) in Hollywood, where “you work for months and months away from your family, only to see your work displayed in movie theaters on screens with dim bulbs, incorrect framing, out of focus lenses, and sound so painfully loud it’s unpleasant.”

Rob said he wanted to “build a theater that will properly showcase films in the manner they were meant to be seen - on a large constant-area screen, with powerful, intense yet delicate sound.”

“I remember seeing ‘2001’ in 70mm in a print struck off the original negative (when it was first released) - I’ll never forget it. I want to create a theater environment that can recreate that awesome experience.”

It took a little while to identify the concepts and R&D programs that might make Rob’s dream come true. Here are three key inspirations that guided us there.

1: A BIG CHASM

Inspired by the vision of sitting under the stars at the edge of the Grand Canyon, legs dangling over the abyss and staring into the blackness, I imagined a giant, brilliant film screen appearing maybe 50 yards in front of us, somehow magically suspended over the canyon, the glowing image surrounded by the huge black chasm. The screen was a vivid window into another world, like a giant light bulb, but with no light-reflecting surfaces around it to dilute the intensity and purity of the filmmaker’s vision.

Together, Rob and I collaborated on architectural sketches and the 3D computer model, which allowed him to navigate around, zoom in and out, and attach notes to elements as large as the stage and proscenium, and as small as the tiniest moulding profile. The result was that our back-and-forth produced something even better than Keith’s Chasm. We got Rob’s Chasm, and it worked.

2: A MIGHTY MONSTER

Human hearing extends down to 2.5Hz, which is three octaves below 20Hz, the low-frequency “limit” tossed around in the AV world. This ultra-deep bass region below 20Hz is referred to as infrasonic. There’s not much natural infrasonic content in music, though movies are positively pulsing with it: collisions, explosions, slams, stampedes, trains, helicopters, thunder, earthquakes, even the relatively distant sound of the family car quietly burbling in the garage.

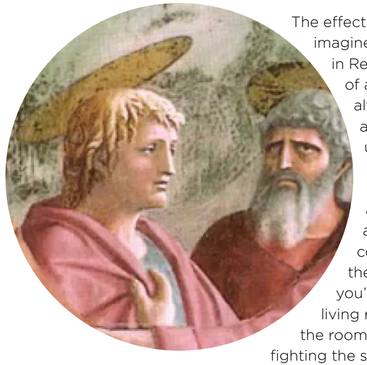
Though it’s easy to find infrasonic-rich movie content, its nearly impossible to find a subwoofer that can actually reproduce it. The physics of infrasonics are punishing: think 2-foot diameter subwoofer drivers in cabinets the size of walk-in closets. This meant Rob would need half a dozen of those closet-size behemoths plus a rack of multi-kilowatt amplifiers to drive them. When Rob said the first test disc he intended to play in his new room was Spielberg’s *War of the Worlds*, I knew we had to actually solve the problem, and cleanly, from 20Hz all the way down to 3Hz.

The end result of tackling this monster of a challenge was the invention of our UberSub™ infrasonic subwoofer.

3: A SIMPLE HALO

One of my college Psychoacoustics instructors had a knack for walking into an unfamiliar space and describing its size, shape, and placement of major furnishings. That might not seem so special, until you consider that she was blind from birth. All of us, blind or sighted, identify our surroundings by the way sound reflects off things in front of, behind, above, below, and to the sides of us. It’s what you hear that creates your sense of what’s all around you.

After that first meeting with Rob, I imagined my blind instructor walking into Rob’s theater, only to give up and say, “I have no idea how big this room is, or its shape, nothing. Yet I hear a room with a rich, natural ambience all around me; it’s alive and glows.”



The effect she was describing in this imagined scene made me think of halos in Renaissance paintings: simple discs of a soft golden color, and almost always nondescript: They didn’t tell anything specific about the person underneath it.

If I could get Rob’s room to create a rich, soft acoustic glow, free of any strong individual reflections, I could stop the room from breaking the spell by announcing, ‘Hey, wait, you’re not in a jungle, you’re just in a living room watching a movie.’ Without the room’s specific acoustic signature fighting the soundtrack’s, Rob would be much more likely to suspend disbelief and enter the movie.

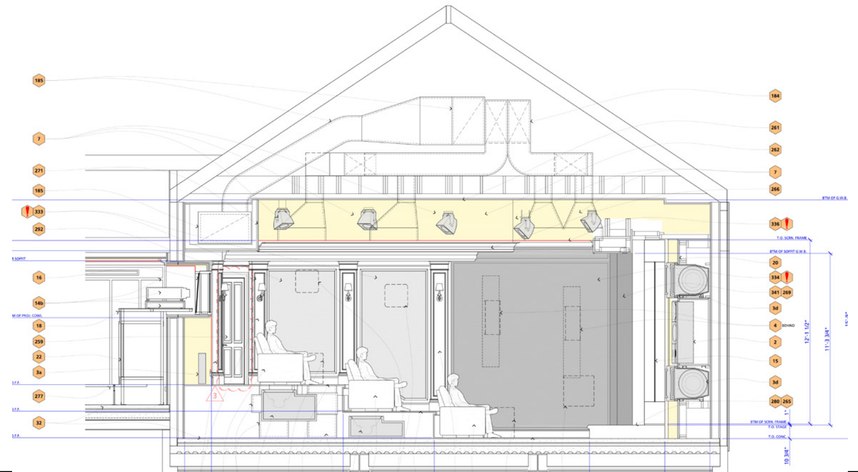
My halo ah-ha! moment led us to model different acoustic schemes using ray-tracing, finite-element analysis, fluid dynamics simulations, and strange 3D microphones designed for concert hall and auditory perception research.

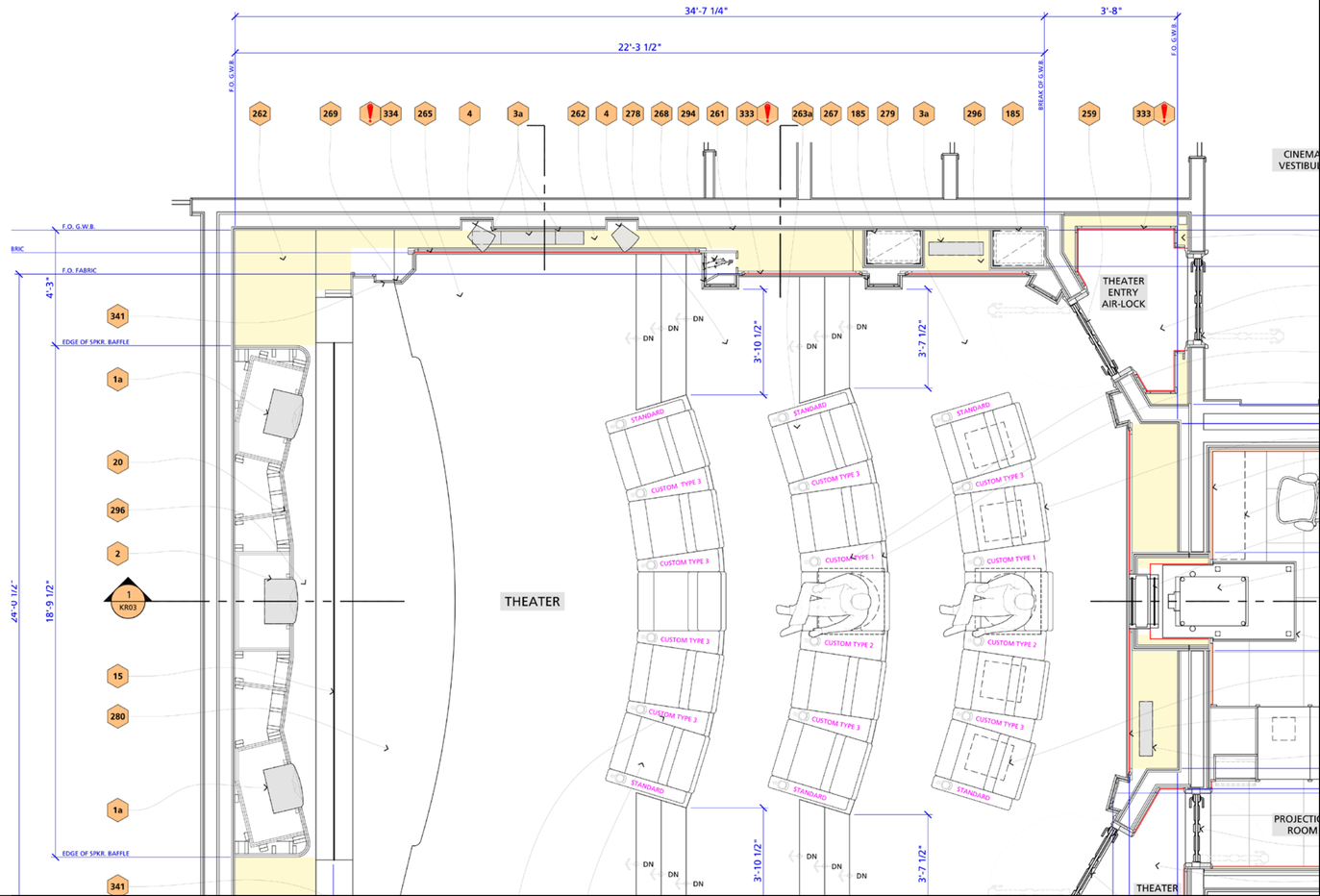
ARCHITECTURAL

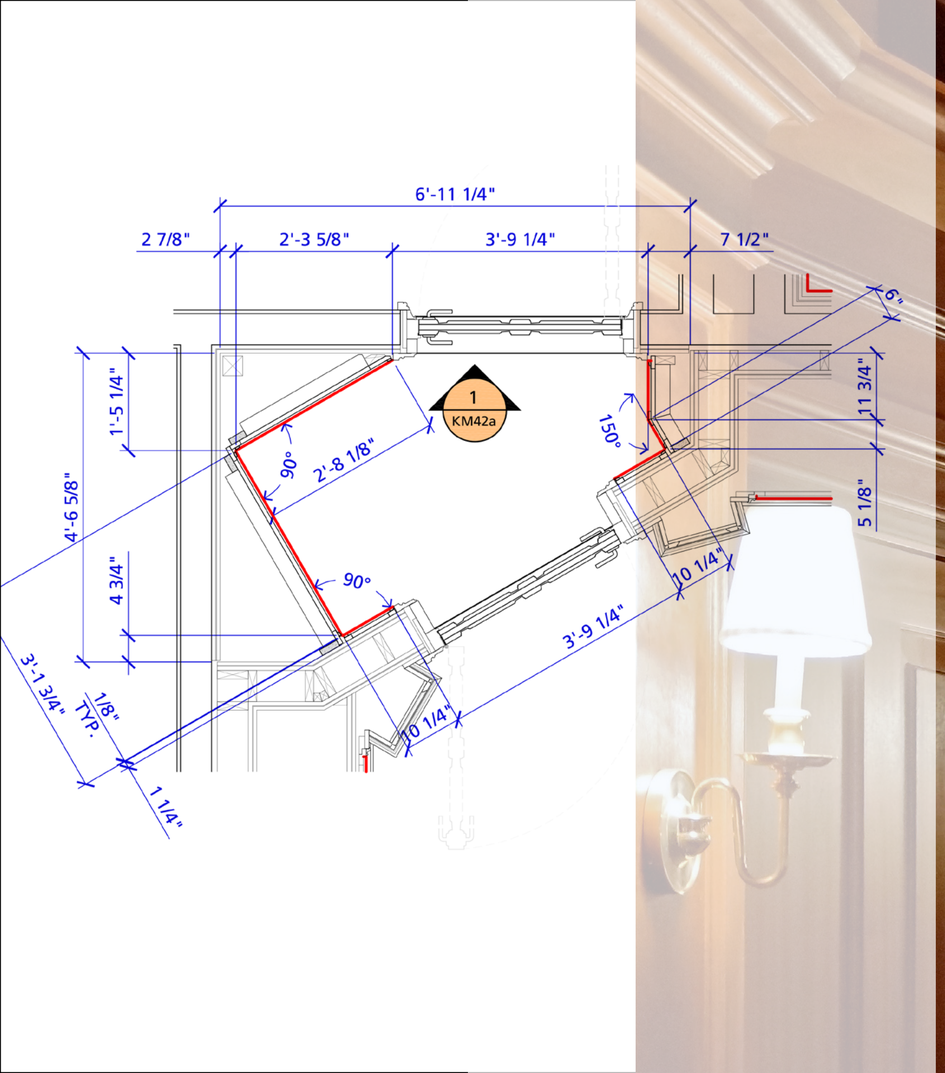
For projects of this sophistication, people often ask,
“Why so many drawings and details of the room’s envelope?”
Answer: Because that’s where the goosebumps are.

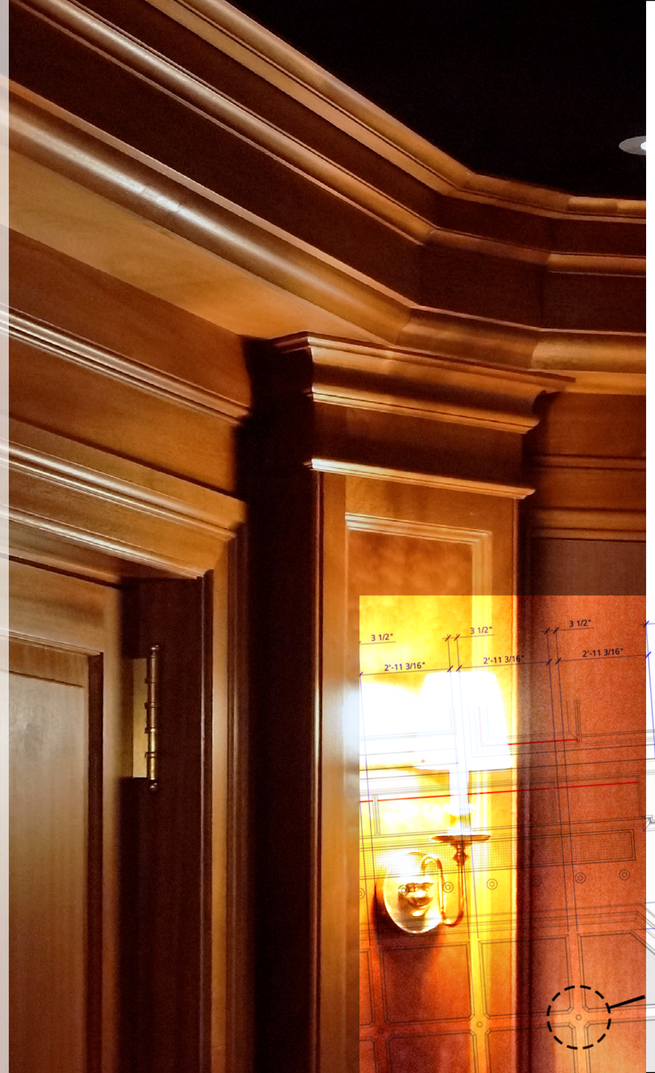
There should be no sound in the room other than the soundtrack
and the breathing and beating hearts of the audience.

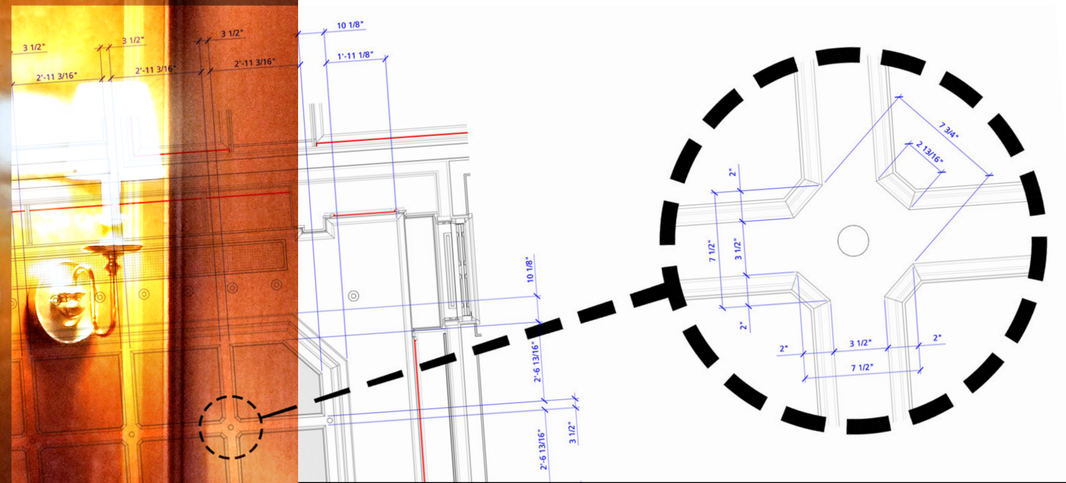
The final Hahn construction drawings package—framing,
electrical, mechanical, acoustical, millwork, A/V, lighting,
interiors—was just over 300 sheets.











MILLWORK

Once we had mapped out a movie-friendly configuration of doors, soffits, pilasters, panels and various mouldings, we brought in our long-time woodworking specialist, Rick Garlick, to draw up the CAD details and propose the wood species, stains and sheens to give Rob the classic, warm look he resonated with.

Then, Rob's local millwork specialist built, stained and finished full-scale mock-ups from mahogany and sapele pommele for Rob and the team to review.

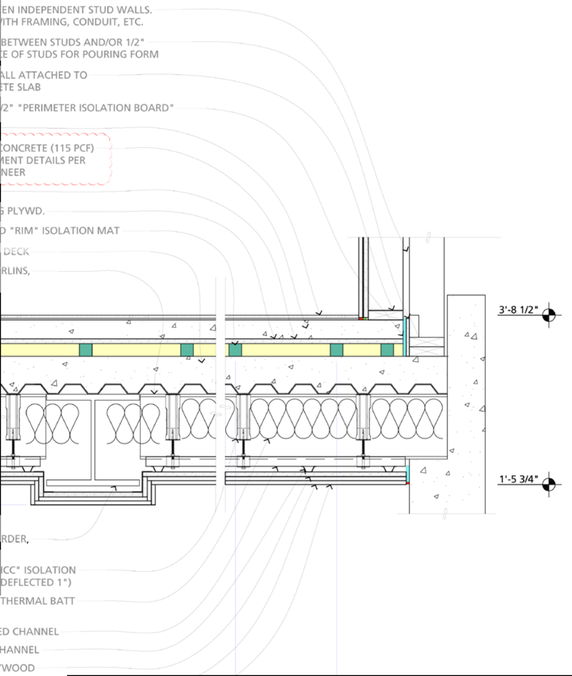
Once the profiles, joinery and custom stain formula were finalized, we "tapered" the sheen levels in the front half of the room to reduce glare distractions in the audience's peripheral vision during bright movie scenes.

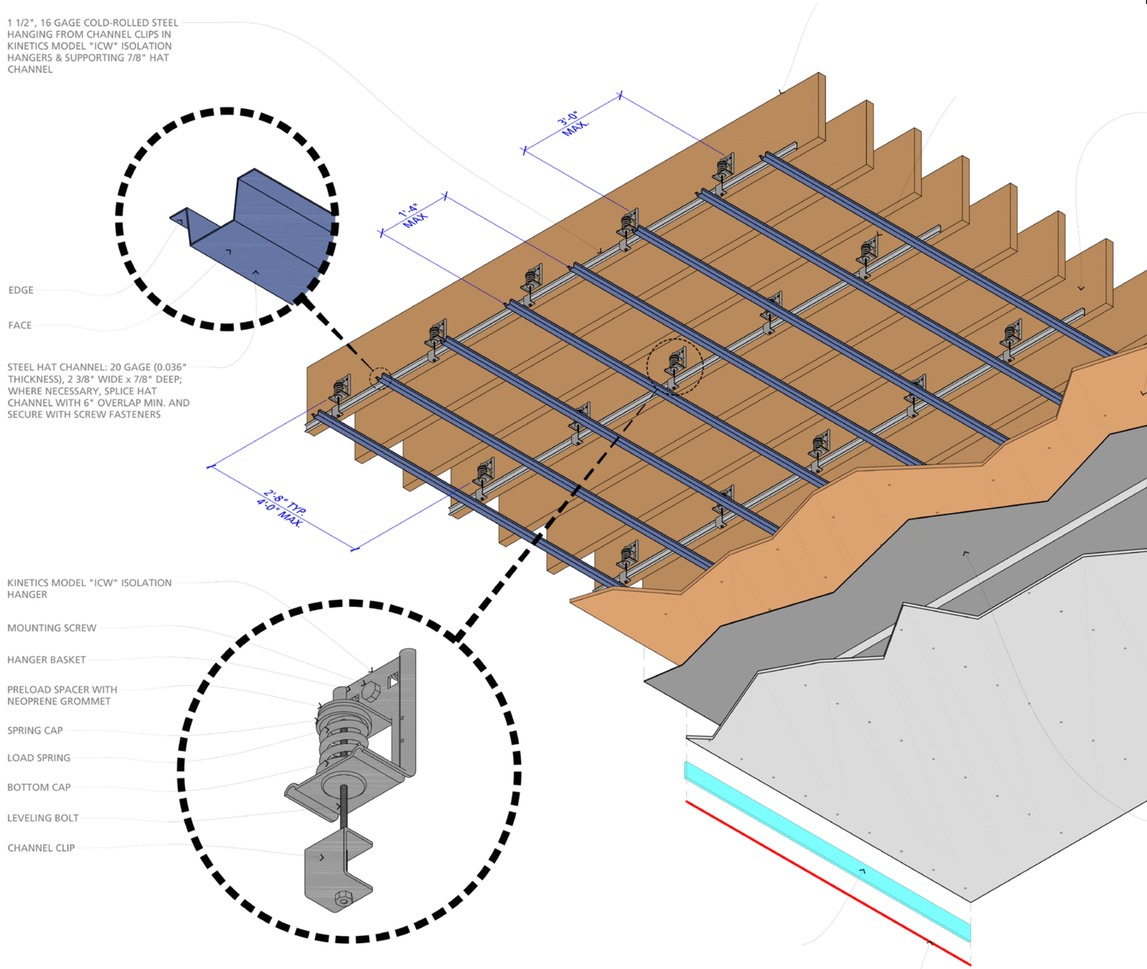
BONES

We'd been designing screening room and private theater envelopes—walls, floors, ceilings and doors—to meet or exceed professional recording studio standards for many years. But with the Hahn Theater we decided that a more suitable noise target was another 15 decibels lower—in fact, down to the human hearing threshold.

With the master bedroom less than 20 feet from the UberSub-equipped theater, the envelope would need to be designed to suppress broadband sound energy as well as infrasonic rumbles and ground-shaking vibrations so Rob's wife could sleep.

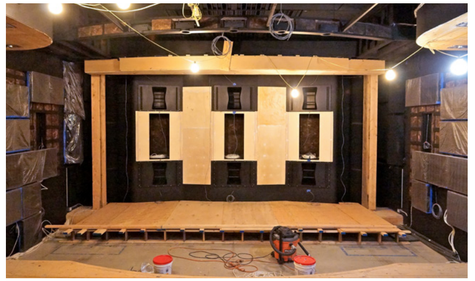
To clarify our design intent for the construction team, we generated details in both standard 2D sections (left) and simple exploded isometric (right) for 15 different wall types for the project, in addition to floating floors and ceilings.



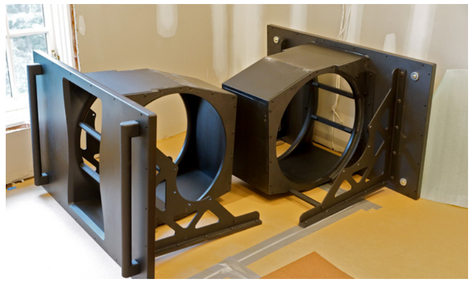














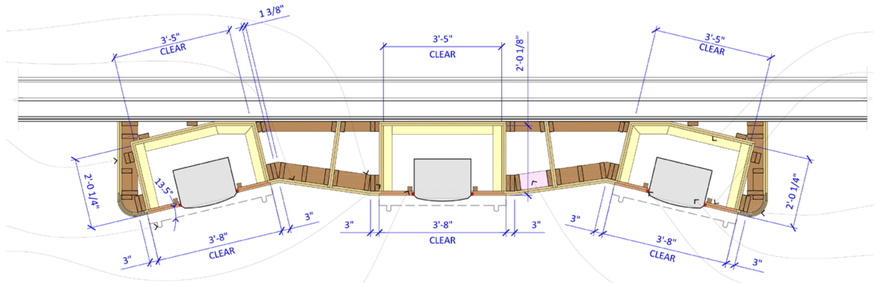


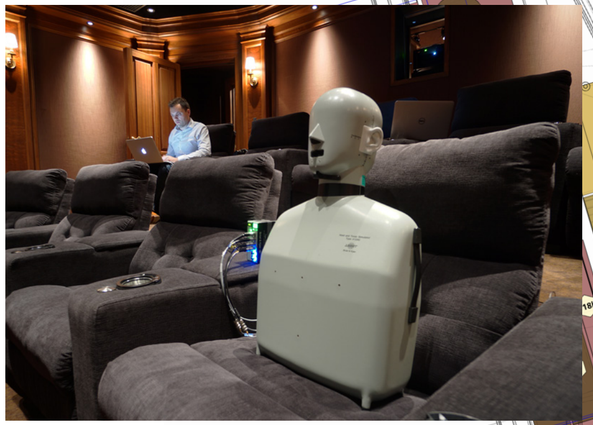
BAFFLE WALL

A Baffle Wall is a large, stoutly-built structure behind the video screen that hosts the main speakers (left, center and right).

The Hahn baffle wall is designed to optimally:

- fix in place the left, center and right speakers so sound source locations perceptually align with the corresponding visual cues from the projected image (the ventriloquism effect);
- aim and vibrationally isolate the speakers from the baffle;
- take full acoustic advantage of the 2-pi boundary benefit of having the main speakers recessed into cubbies and aligned with the face of the baffle;
- provide surfaces for acoustic treatments to suppress stray high-frequency reflections from the steel video frame, and back-scatter/comb-filtering from the microperforated image surface;
- enable flexibility in the installation, servicing and replacement of the main speaker types and sizes (active/passive, large/small, thermal regulation, etc.); and
- create 6 ideally sized and damped, resonance- and leak-free dockable 'enclosures' for the 300-pound UberSub motor assemblies to slide into and out of.





ACOUSTIC TECHNOLOGY

That rare but addicting you-are-there effect depends on the absence of noise, light reflections, vibrations, resonances, and other stimuli unrelated to the movie's actual content.

The weakest link is almost always the room itself, especially how it absorbs, reflects and scatters sound. The Hahn Theater acoustic treatment plan was modeled and tuned per the results of computer simulations of energy decay times, speech intelligibility, clarity, envelopment and other metrics throughout the seating area.

The design and tuning of the Hahn acoustics were guided by tests conceptually similar to those used to evaluate ambitious modern concert halls.

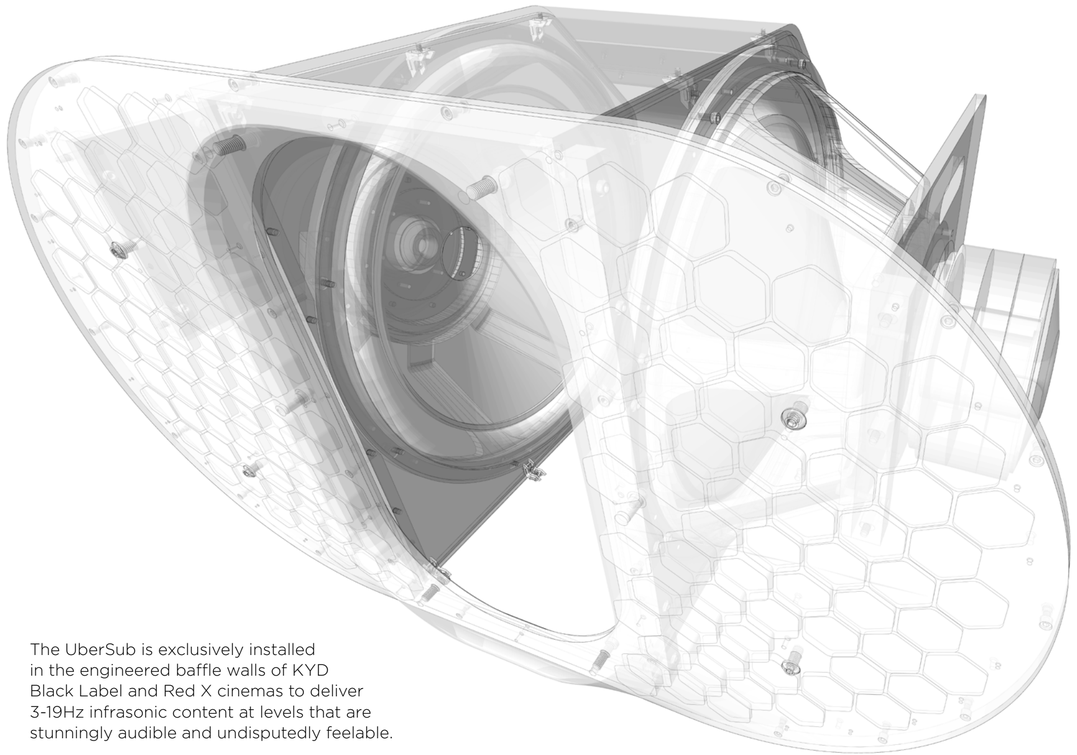
UBERSUB™ INFRASONIC SUBWOOFER

The Hahn Theater was the prototype and first venue in the world to be powered by UberSubs in the extreme low bass.

Designed and manufactured in California, each UberSub module is comprised of a pair of KYD U-571 long-throw, horizontally opposed, force-canceling 24-inch drivers. Driven by 6,000 watts per module, the UberSub system brings a deeply physical, feelable dimension to movies by plumbing deeply into infrasonic realms not reachable by conventional subwoofers.

As installed in the engineered baffle wall in the Hahn Theater, the 6-module UberSub system generates 120 decibels throughout the 15-seat audience area down to 3Hz, with less than 3% total harmonic distortion and no detectable buzzing or rattling in the room.

More than just a new product category, the UberSub is built on a multidisciplinary Program designed to deliver life-like realism, both audible and feelable, throughout the 3-octave range below “deep bass.”



The UberSub is exclusively installed in the engineered baffle walls of KYD Black Label and Red X cinemas to deliver 3-19Hz infrasonic content at levels that are stunningly audible and undisputedly feelable.

A/V TECHNOLOGY

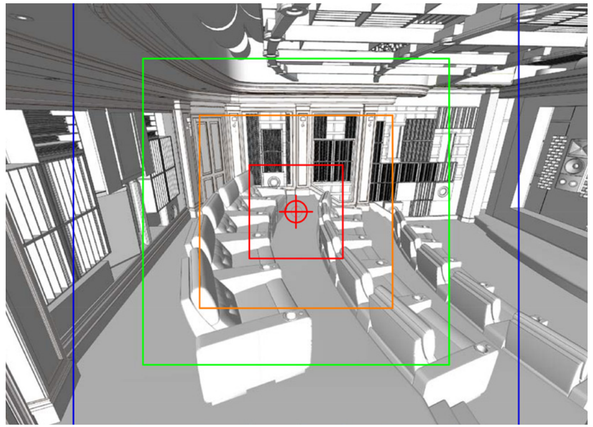
You might wonder what video choices an acclaimed cinematographer makes when it's his own money. Answer: a Sony VPL-5000ES projector illuminating a 19-foot wide Stewart Director's Choice screen, a combination that regularly elicits audience gasps in the deep black scenes in *Gravity*.

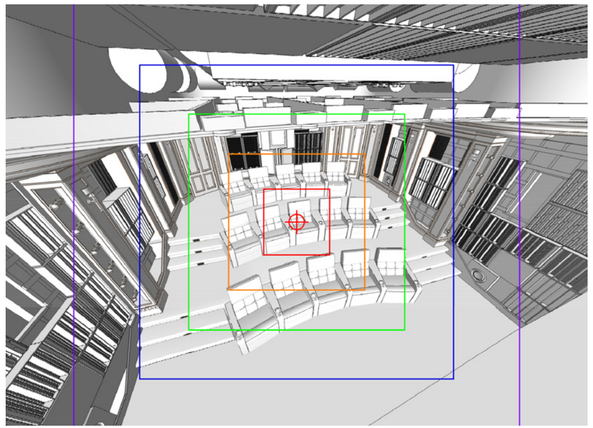
An equal part of the Hahn lights-off experience is created by the three JBL M2 loudspeakers in the baffle wall, and matching JBL surrounds – 23 speakers supported by 16 subwoofers in all, including 8 custom KYD/ JL Audio SHOC-24 subwoofers at the side and rear walls, 2 custom 24-inch U-571 Uber drivers in custom enclosures below the audience, and 6 UberSub modules in the baffle wall.

The 3 front speakers are powered by Mark Levinson amplifiers, while the 20 surrounds are driven by JBL Synthesis amps. Four Powersoft X4 4-channel amplifiers drive the 6 dual-driver UberSubs in the baffle wall behind the screen and the 2 24-inch subs in large custom enclosures just below the audience. They're managed by a Trinnov Altitude 32 surround processor fitted with Dolby Atmos and DTS:X immersive audio decoders and Lake DSPs.

Feeding the 3 theater racks are 6 basement-level racks with a comprehensive Kaleidescape media system to manage Rob's movie collection, which includes over 2,500 Blu-rays in the Kaleidescape Premier HD disc vaults, and nearly 1,100 Blu-ray quality downloads from the Kaleidescape Store. His roughly 500 4k UHD Kaleidescape downloads reside on Kaleidescape Strato and Terra servers.

Detailed sound and picture adjustment presets were created for Rob's use, depending on the program material and which row he chooses to sit in.



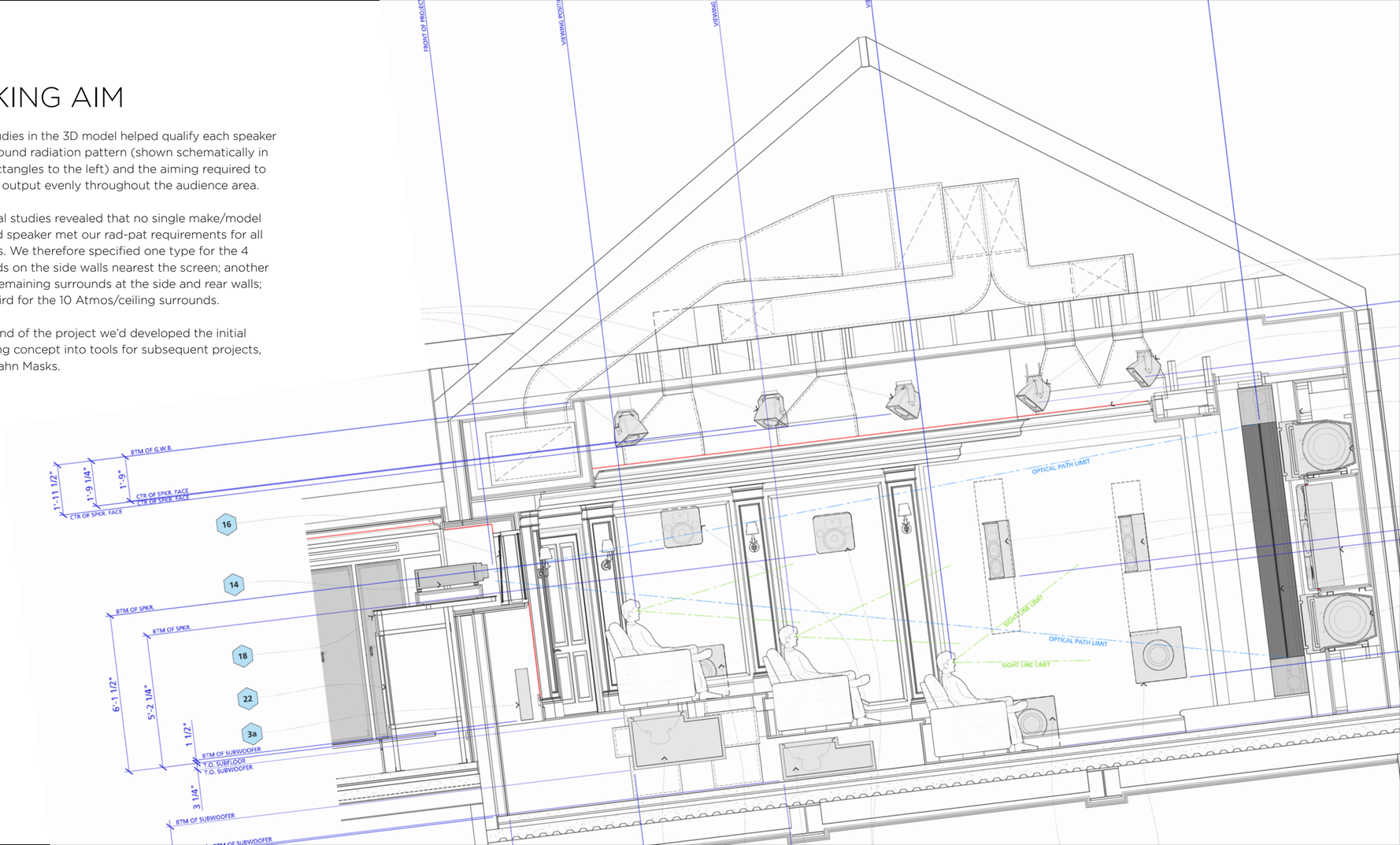


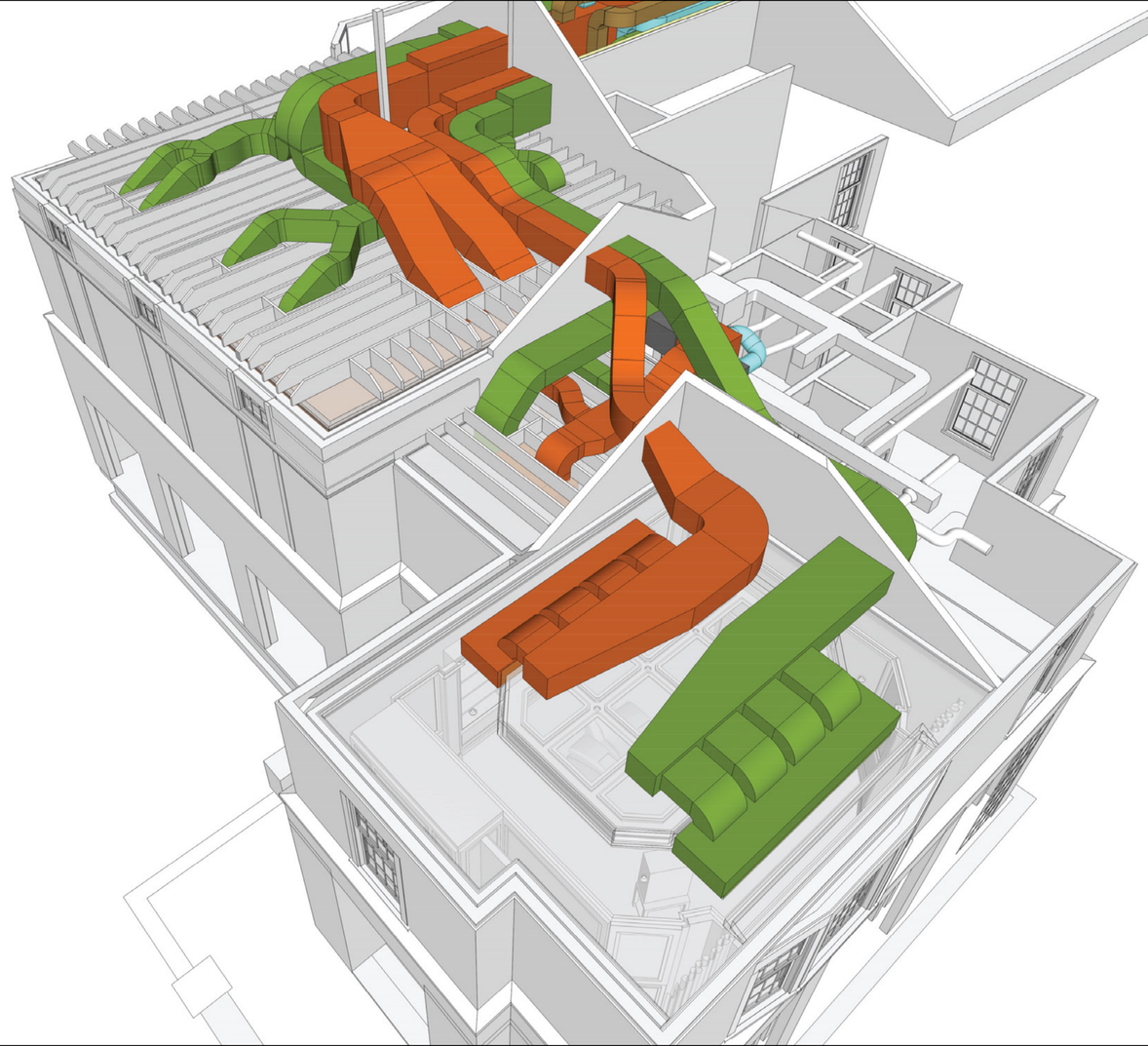
TAKING AIM

Initial studies in the 3D model helped qualify each speaker per its sound radiation pattern (shown schematically in color rectangles to the left) and the aiming required to 'land' its output evenly throughout the audience area.

The initial studies revealed that no single make/model surround speaker met our rad-pat requirements for all locations. We therefore specified one type for the 4 surrounds on the side walls nearest the screen; another for the remaining surrounds at the side and rear walls; and a third for the 10 Atmos/ceiling surrounds.

By the end of the project we'd developed the initial 3D aiming concept into tools for subsequent projects, called Hahn Masks.





HVAC

With the room envelope and projector enclosure optimized to reject intrusive noise, the heating/cooling system stood as the largest source of noise pollution.

The noise criterion was set at NCB 0 with the HVAC system operating at 7-10 air changes per hour. This ventilation rate, driven by our Indoor Air Quality requirements, is 3 to 4 times higher than commonly achieved in custom homes in North America.

The measured result was NCB -6 (minus 6), which is just below the human hearing threshold, and appreciably quieter than any known residence or professional cinema, dubbing stage, director screening room or recording studio in the world.

Rob reports that, when first entering the Theater, his friends and movie-industry colleagues remark that, in contrast to the closed, claustrophobic nature of anechoic test chambers and other ultra-quiet environments, his theater is the opposite, sounding large, spacious and airy. “I can’t tell you how many times I’ve heard, ‘I could live in here, starting right now, Rob!’”

TECHNICAL POWER

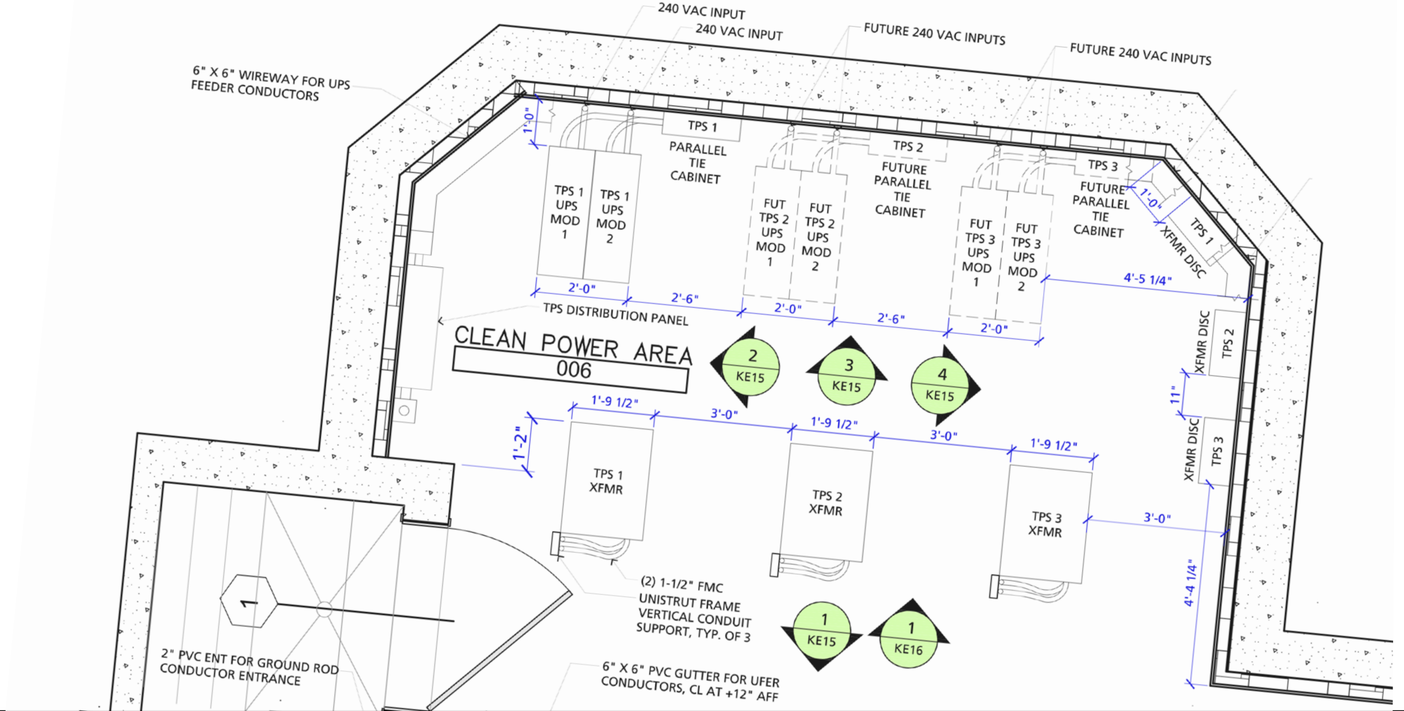
In rooms as quiet as the Hahn Theater, any faint electrical buzzing can take you out of the movie.

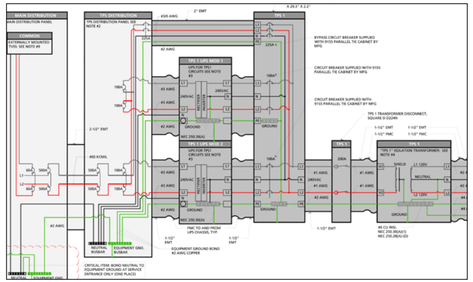
A TPS is a separate, industrial-strength, engineered electrical system for noise-sensitive electronics and mission-critical equipment in government and industry labs and data centers. As with all KYD Black Label projects, the Hahn Theater has a true Technical Power System per the National Electric Code.

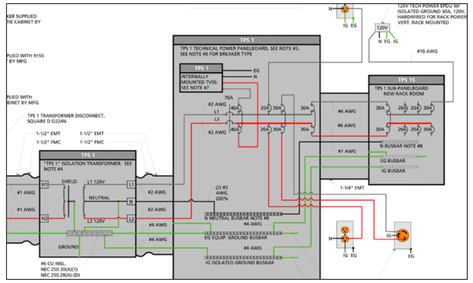
Low-noise electrical systems depend on a low-resistance ground path to the earth. The TPS design program began by performing soil resistivity tests throughout the property, which revealed the highest resistance, i.e. poorest results, we'd ever encountered. (It turned out that Connecticut soils have something of a reputation among TPS engineers.)

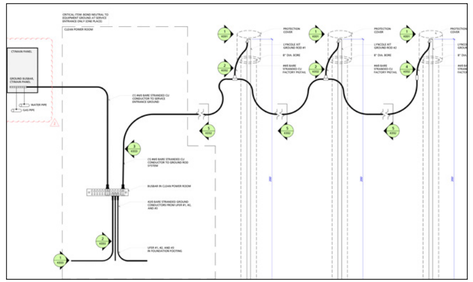
The solution involved drilling 200-foot deep holes throughout the property and installing electrolytic ground "rods" (copper tubes filled with special mineral salts) to lower the ground-path resistance enough for us to achieve our noise targets.

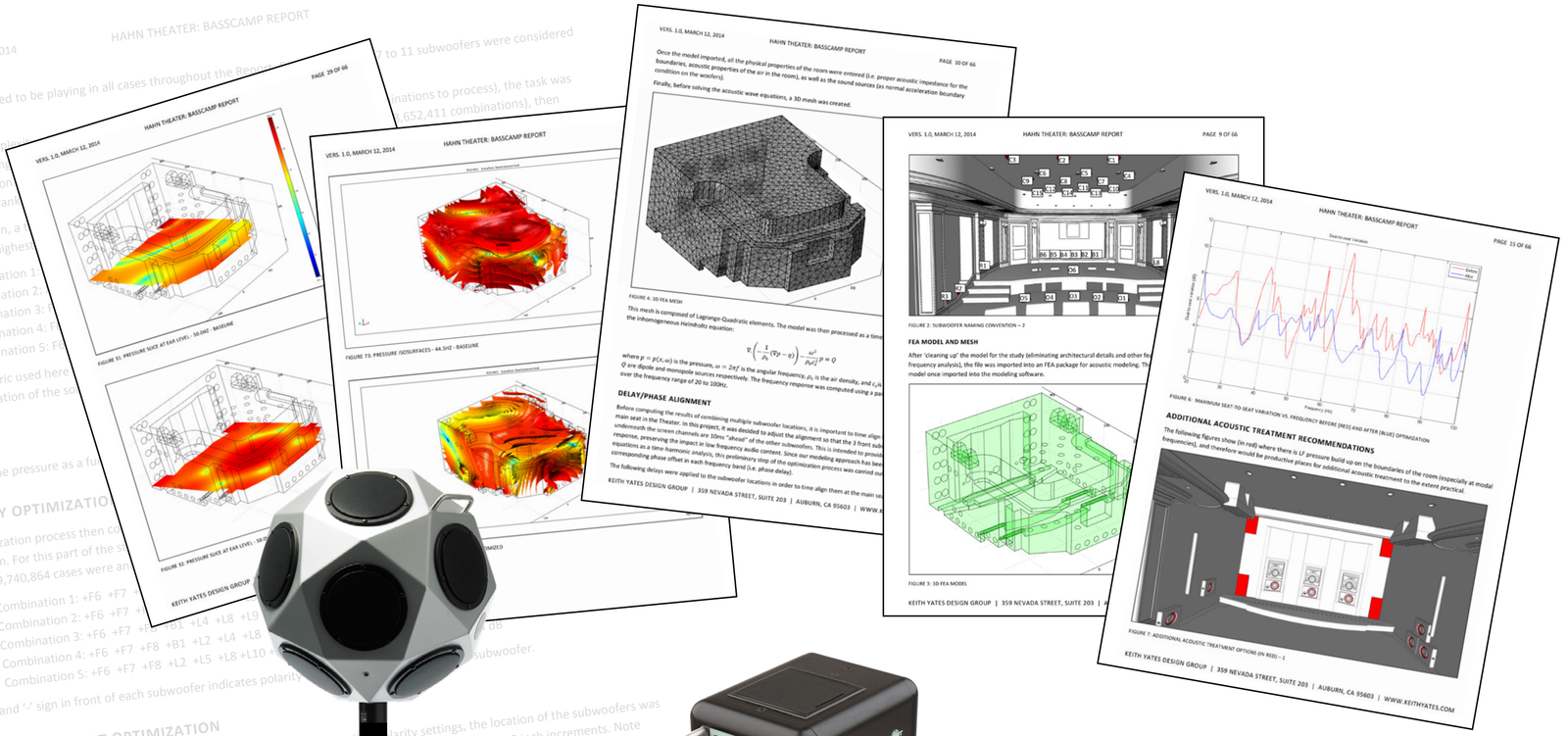
The TPS section of our final construction drawings ran 32 sheets.









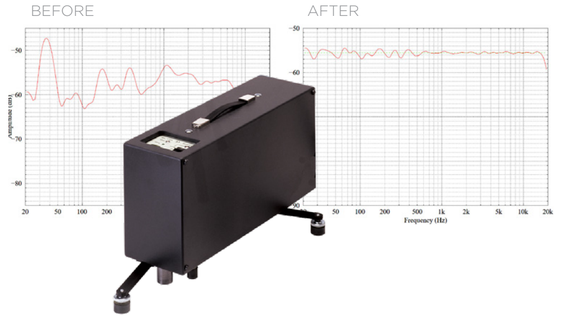


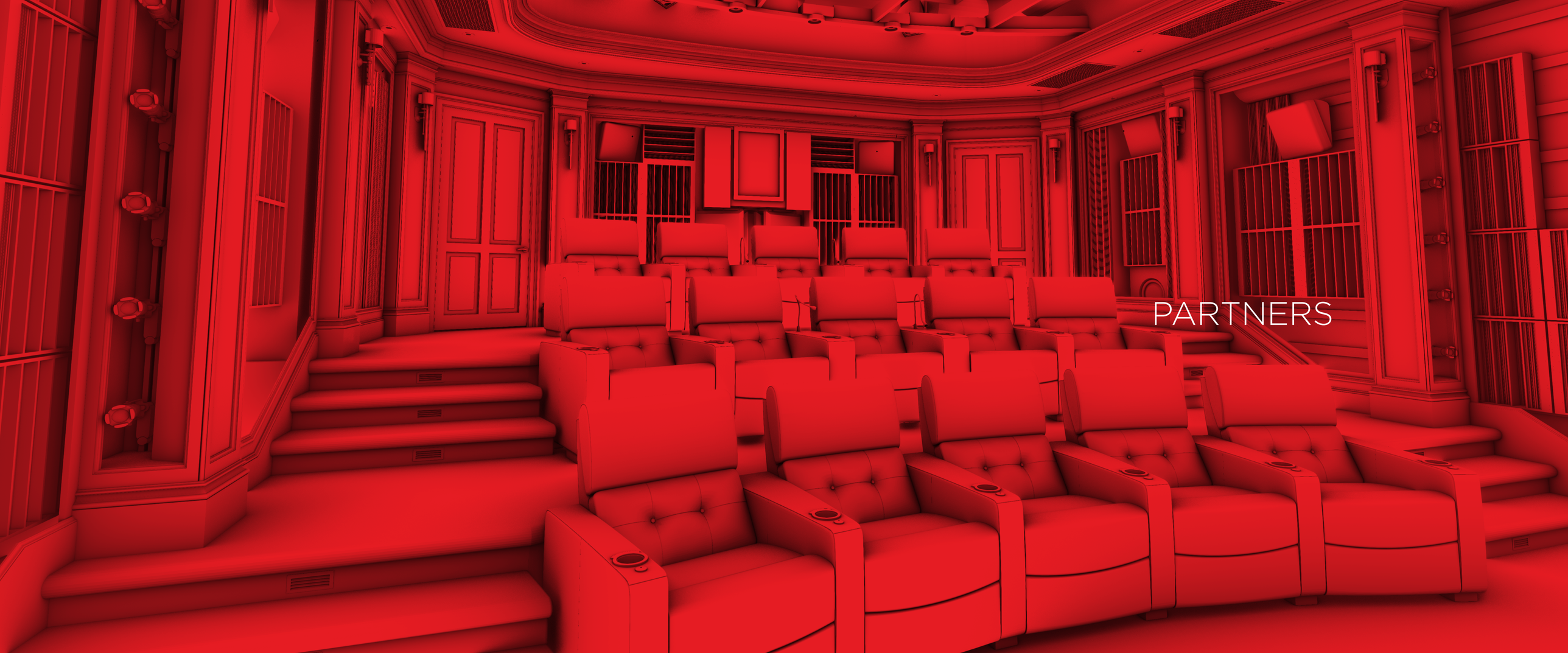
SCIENCE & REPORTS

Acoustics transitioned from predominately Art to predominately Science back in the 1970s. We start with ideas and measurable performance targets that align with the known laws of human auditory perception, then create physical or mathematical models that show us various ways to achieve them.

Once the plan works on paper and in our “auralizations,” i.e., headphones-based 3D simulations, we detail the results in our 3D model and construction drawings, set up sensitive instruments to test what we actually achieved, then issue a report to the client and project team to validate the design.

There are six such reports in a Black Label project, each ~50 pages.





PARTNERS

Special Thanks...

to my KYD team members most involved in the project: Andrew Steele, Remi Audfray and Bob Markham (engineering); Kyle Cramer (CAD); and Mike Moore (construction administration);

to Rick Koch, his son Gill, and Bob Cebulski of Davenport, whose collective trust and dedication to “getting it right” were an inspiration to everyone involved; and

to Geoff Franklin and his team at The Projection Room for his care and attention to the entire Project.

How does one design a theater that provides this all-encompassing experience? Hire Keith Yates!

By having Keith design my theater, I can completely control the presentation to make sure the film is presented properly. We recently screened *West Side Story* for friends, and most had never seen it on a big screen. They were awe-struck.

Every one of my guests starts rattling off dozens of movies they want to see now ‘for the first time’ (whether they’ve previously seen it or not). Thanks to Keith, his team, and all the people from The Projection room and Davenport Contracting for helping me realize my dream.

Rob Hahn

THE PROJECTION ROOM
INTEGRATING TECHNOLOGY

GFranklin@projectionroom.net

DAVENPORT

davenportcontracting.com

JBL SYNTHESIS®

3 SDA-8300 (8x300-watt) power amplifier
1 SDA-4600 (4x600-watt) power amplifier
3 M2 Main (left, center, right) speakers
4 AC28/26 Front side surround speakers
6 8340A Side and rear surround speakers
10 SCS-8 Top/ceiling surround speakers

JBLsynthesis.com

JL AUDIO®

8 SHOC-24 with IWSv2 amplifiers

JLaudio.com

kaleidescape

1 Strato Movie player
12 DV700 Disc vaults
2 Terra Movie server

kaleidescape.com

3 No.531H 300-watt mono power amplifier, drive woofers of JBL M2 spkrs

1 No.533H 3x300-watt/channel power amplifier, drives high-frequency sections of M2 spkrs

marklevinson.com

1 Directors Choice 4-way masking video screen, microperforated Sno-Matte, 228" x 110" video image

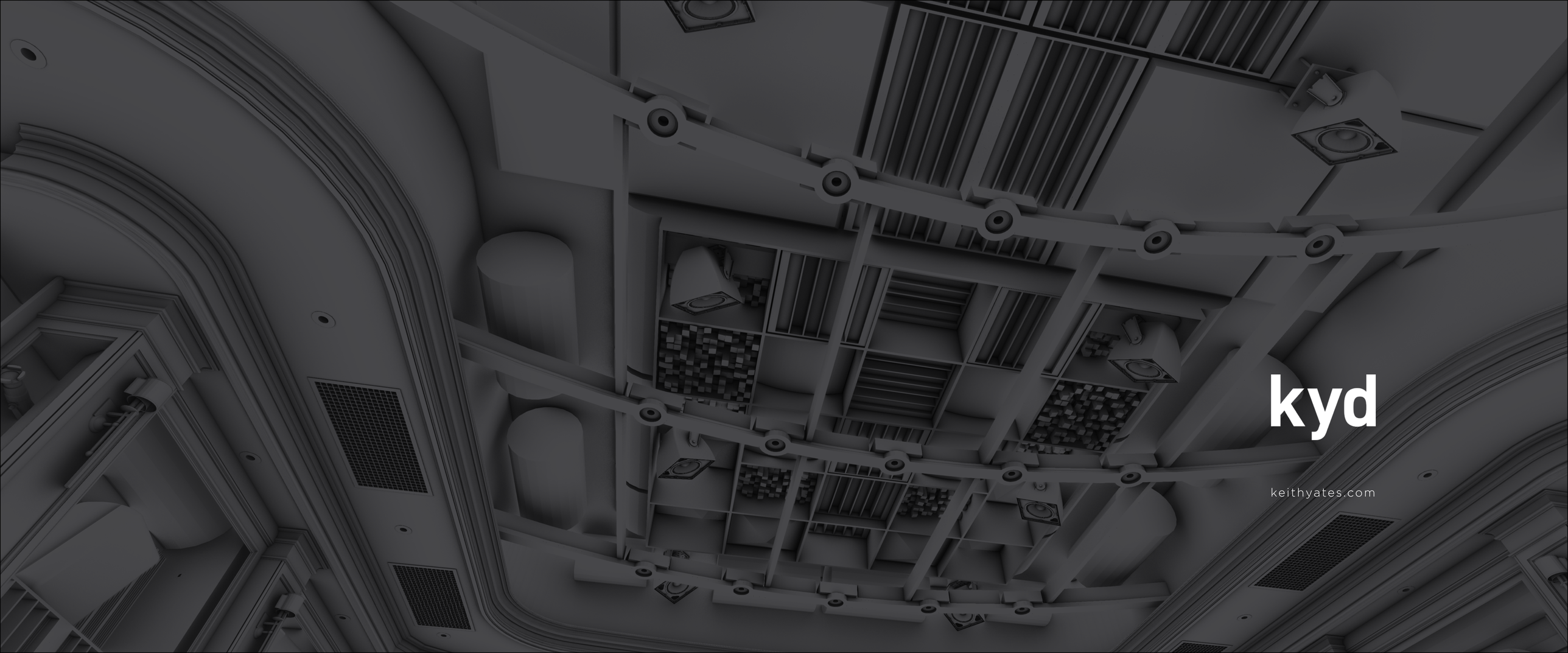
stewartfilmscreen.com

1 4K SXRD Home Cinema Projector VPL-VW5000ES, 5,000 lumen brightness

sony.com

1 Altitude 32-channel Preamp Processor, Dolby Atmos, DTS:X Auro-3D

trinnov.com



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