AIA Course Number:

ArmEx207

Wood Specialty Ceilings and Walls:

Art, Science, and System

Credit: 1.5 AIA LU/HSW

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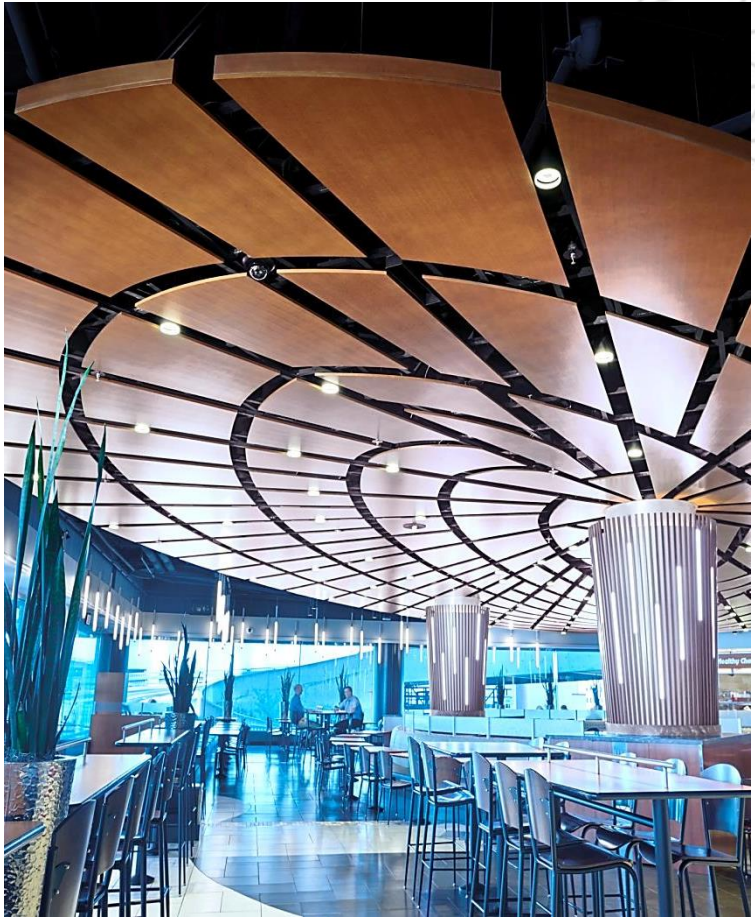
Learning Objectives

- Discuss the role of wood specialty ceilings in commercial buildings, including new integrated, pre-engineered systems.
- Evaluate how aesthetic choices interact with performance, safety and durability, in a broad range of standard, custom and one-of-a-kind design options.
- Examine key performance attributes: acoustics, fire performance, accessibility to the plenum, seismic performance, moisture resistance, sustainability including contribution to USGBC LEED rating system, and installation.
- Recognize how the manufacturing process of wood panels determines their appearance, performance, lead time, and cost.

Wood Ceilings and Walls

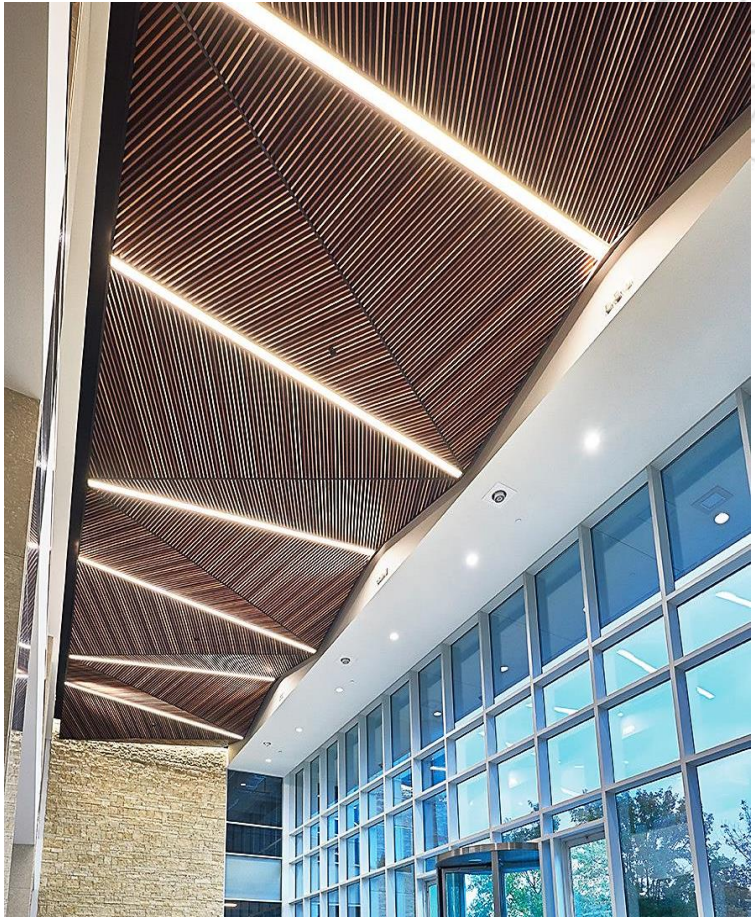
- Visual impact of wood makes it a focal point in dramatic “statement” spaces
- Traditional building material in inventive new designs



Gulf Canada Square Food Court, Calgary, AB (Architect: Stantec)

Wood Ceilings and Walls

- Custom millwork was once primary option.
- New manufactured panels and systems combine beauty with performance, reliability, precision, and durability.
- Almost unlimited choices in finish, form, size.
- Standard, custom, one-of-a-kind options available.

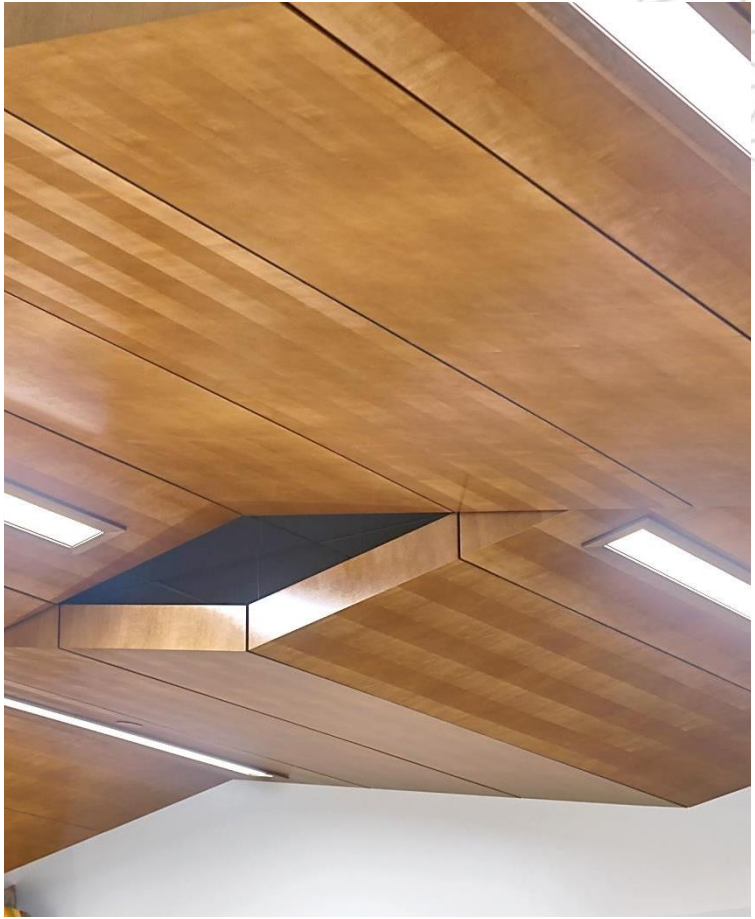


Seeing the possibilities early:

- Lower cost
- Shorter lead time
- Better performance

Aesthetic choices directly related to performance.

- Acoustics
- Fire and seismic safety
- Efficient access to the plenum
- Moisture resistance
- Sustainable materials and healthy interiors

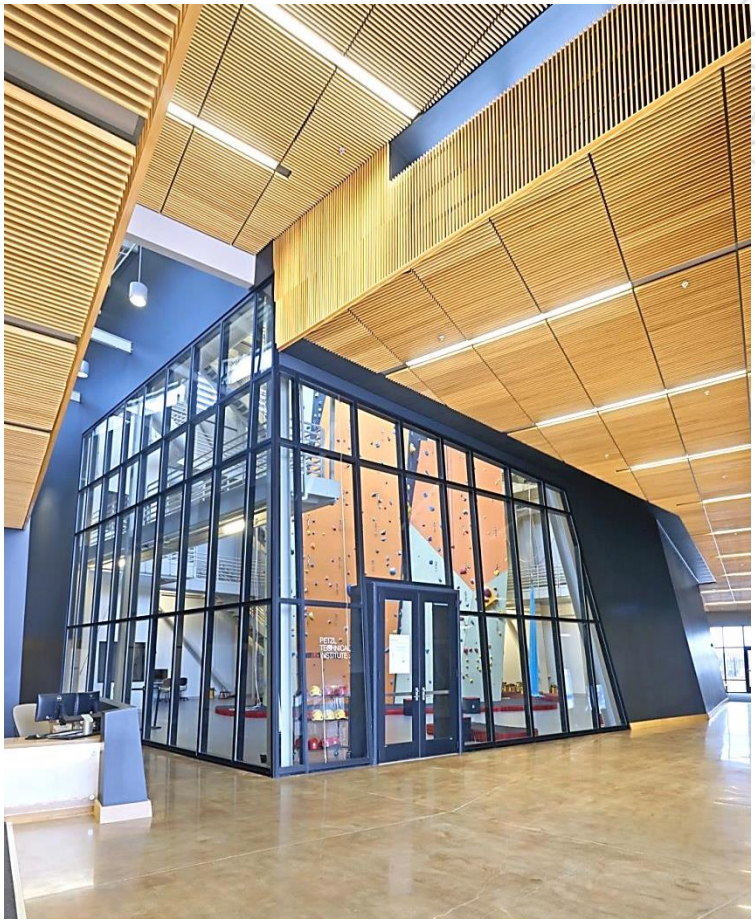


Aesthetics as Performance

- Human connection to natural materials.
- Beauty is an important performance attribute.
- Wood used for specific purposes in many different applications.
  - Healthcare, to promote healing.
  - Education, for feature spaces.
  - Offices, to reduce stress, improve concentration.
  - Many others, to heighten design effects.

Design Options

- Design vision based on client's product and philosophy.
- French climbing gear manufacturer wanted interior to emphasize verticality.
- Customers are climbers, cavers, window washers, tree trimmers.
- Wood grille adds color, texture, directionality.

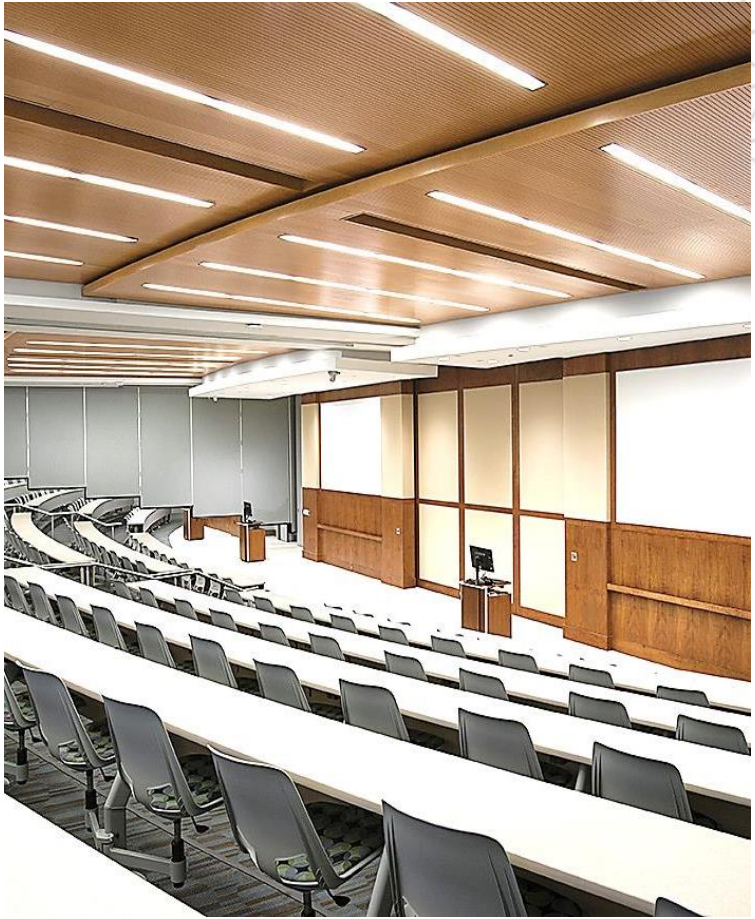


Petzl North American Headquarters, West Valley City, Utah

Architect: AJC Architects, Salt Lake City, UT

Material

- Veneer, a thin layer of real, high-grade wood.
- Adhered to MDF substrate (medium density fiber board).
- Veneered panels, unlike solid wood, can meet Class A fire performance requirements.
- Infinite variations color, grain, texture.



Veneer

- Thousands of species of wood can be made into veneer.
- Every tree in each species is unique.
- Many common species can also be stained to match more exotic species.
- In properly manufactured panels, veneers are applied to both sides of the substrate.

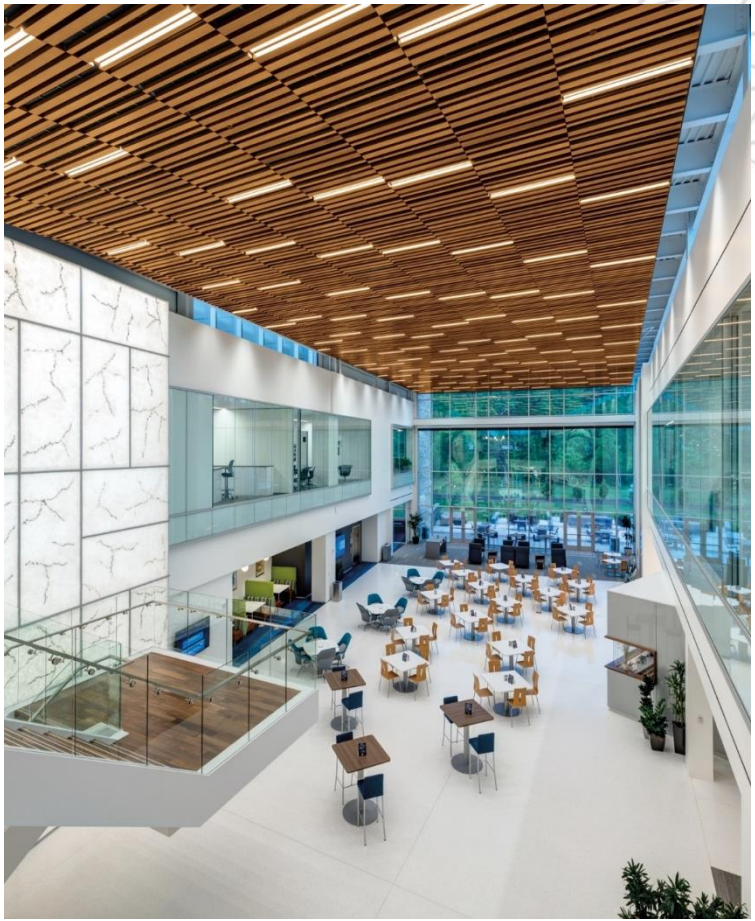
Perforation Patterns

- Openings, or perforations, allow sound to penetrate the panel and be absorbed by acoustical material.
- Pattern can also have striking visual effect.
- Shapes can be used in standard patterns such as rows, slots, diagonal, and in custom patterns.

Image: Randall Children's Hospital

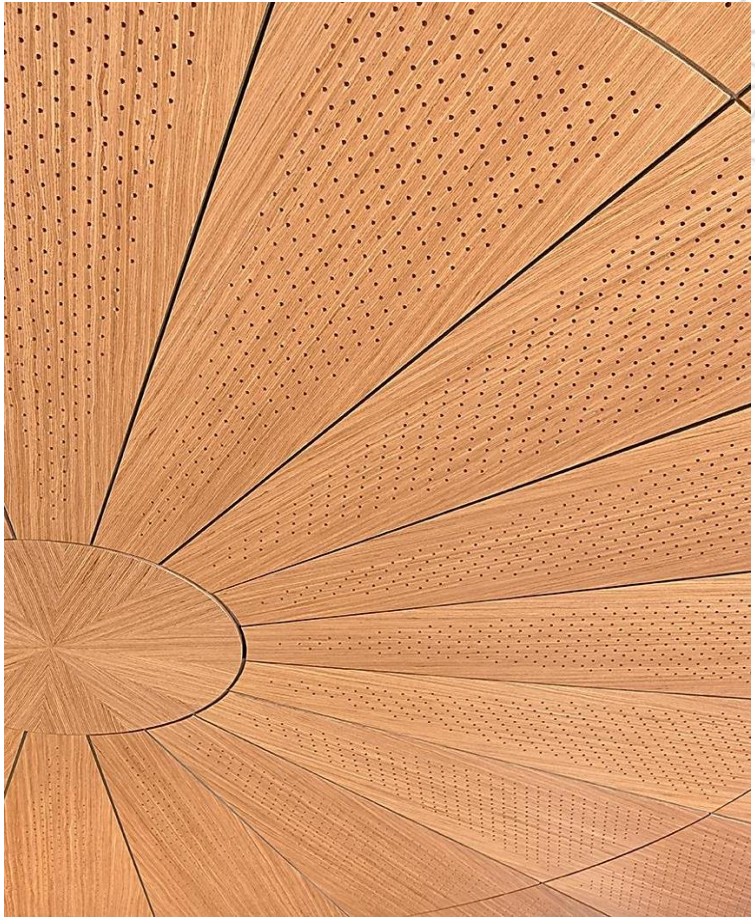
Panel Sizes

- In general, the larger the panel, the more costly the ceiling.
- Very large panels sometimes used to great effect.
- Wide variety of panel sizes: standard 24 x 24 inch to 48 x 96 inches.



Shapes and Forms

- Standard components can be mixed, matched, combined:
  - Finishes
  - Sizes
  - Edge treatments
  - Reveal profiles
  - Installations



Shapes and Forms

- Linear: flat, channeled or tapered, including panels, planks, slats, grilles.
- Curved edges for a radius effect.
- Canopies formed in convex, concave, s-curves.
- Three-dimensional facets, coffers, and open cells.

Installations

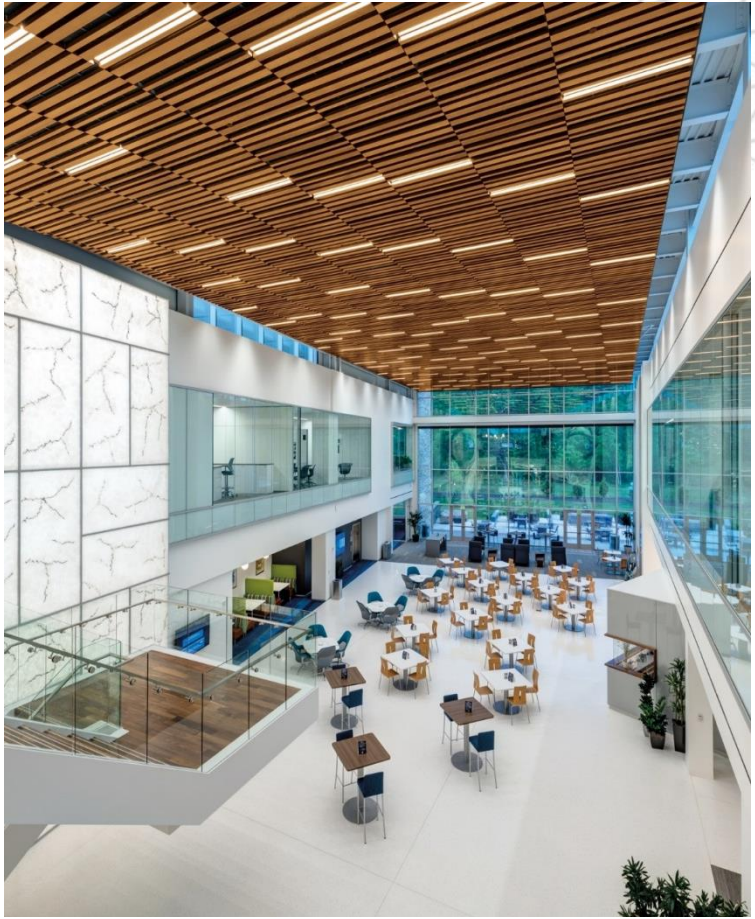
- Concealing the suspension completely for monolithic visual.
- Partially concealed suspension in Clouds.
- Ceiling planes installed at different angles, or continuing down into walls.

Chandler City Hall Council Chambers, Chandler, AZ (Architect: SmithGroup, Phoenix, AZ)

The Botanical Research Institute of Texas, Ft. Worth, TX (Architects: H3 Hardy Collaboration Architecture, New York, NY; and Corgan Associates, Dallas, TX)

Design Options

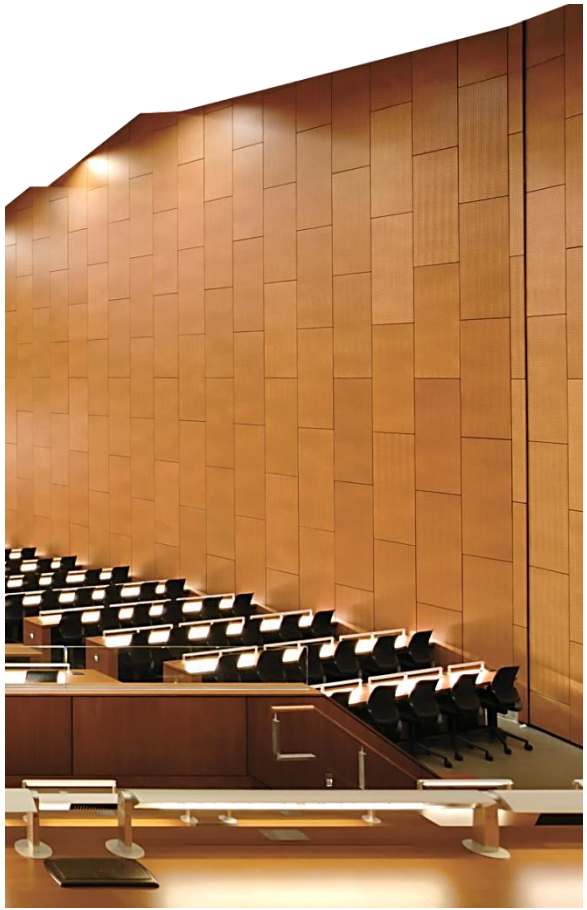
- Aesthetic possibilities of the materials and shapes interact with performance.
- Wood panels give three-story atrium warmth and intimacy.
- Grill design related to company's products and history.
- Ceiling curves down at back of atrium.



Design Options

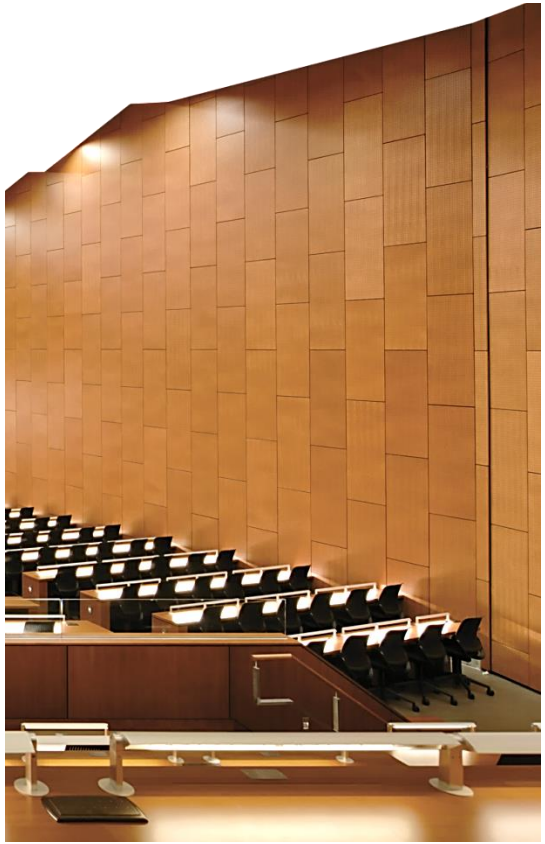
- Acoustic performance carefully calibrated in perforation patterns.
- 28,000 square feet of custom wood ceilings and walls.
- Sloped, stepped ceiling has five different elevations from front to back.

University of California San Diego, Telemedicine & Medical Education Building
La Jolla, CA (Architect: Skidmore Owings and Merrill, San Francisco, CA)



Design Options

- Where sound reflection is desired, perforations only go half-way through the panel.
- Where more sound absorption is required, perforations go all the way through, backed with acoustical material.
- Panel joints staggered, rows of perforations in perfect alignment.



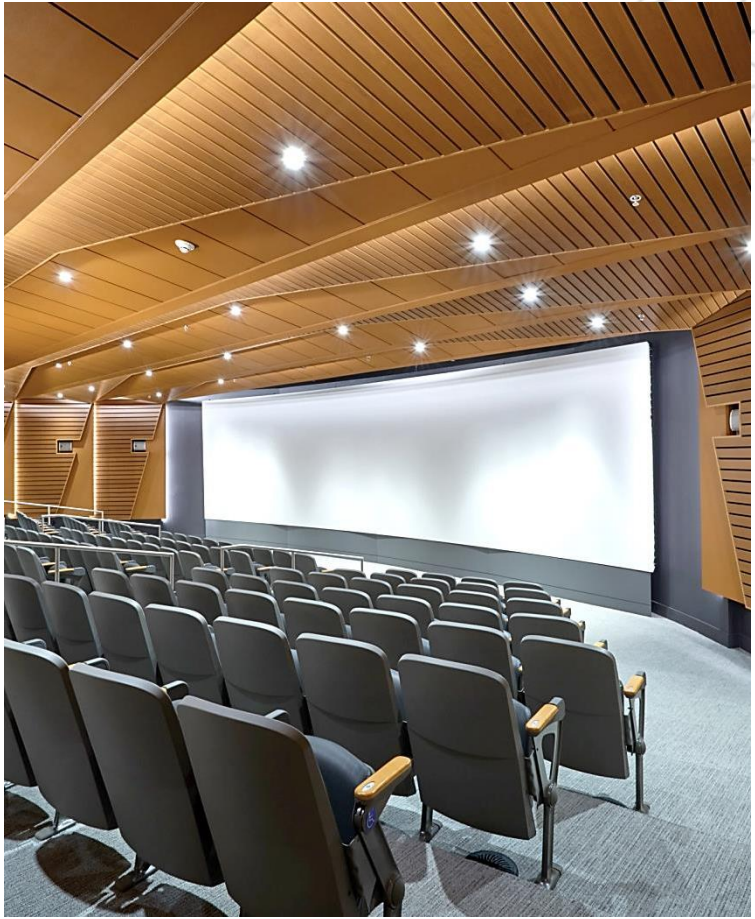
Adding Performance

Following sections focus on important considerations for combining beauty with performance:

- Acoustics
- Fire Performance
- Seismic Performance
- Accessibility to the plenum
- Sustainable spaces, including LEED contribution
- Installation and integration

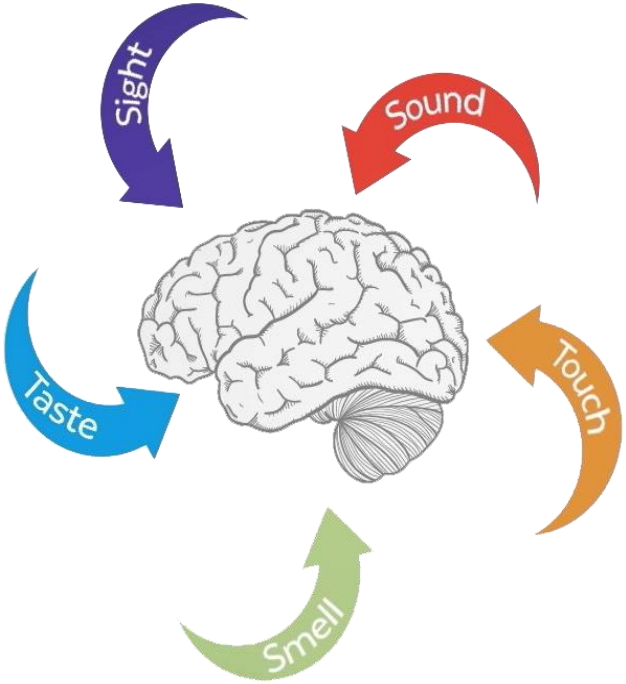
Acoustic Performance

- Noisy, chaotic environments are unpleasant, unhealthy, unproductive.
- Acoustics directly affect human performance.
- Healthcare, education, workspaces all need to control noise.



Acoustic Performance

- Avoid negative acoustic conditions
- Create positive responses, improved performance.
- “Multisensory integration” Senses working together are “superadditive”
- New wood ceiling systems appeal to vision and hearing.



Acoustic Performance

- Ceilings often have severe trade-off between sight and sound, aesthetics and acoustics.
- Now there's a broad range of options that can effect acoustical performance.
- Panel size, edge details, trims, and accessories can all enhance acoustics.

NRC (Noise Reduction Coefficient): measures on a scale from 0-perfect reflection, to 1-perfect absorption.

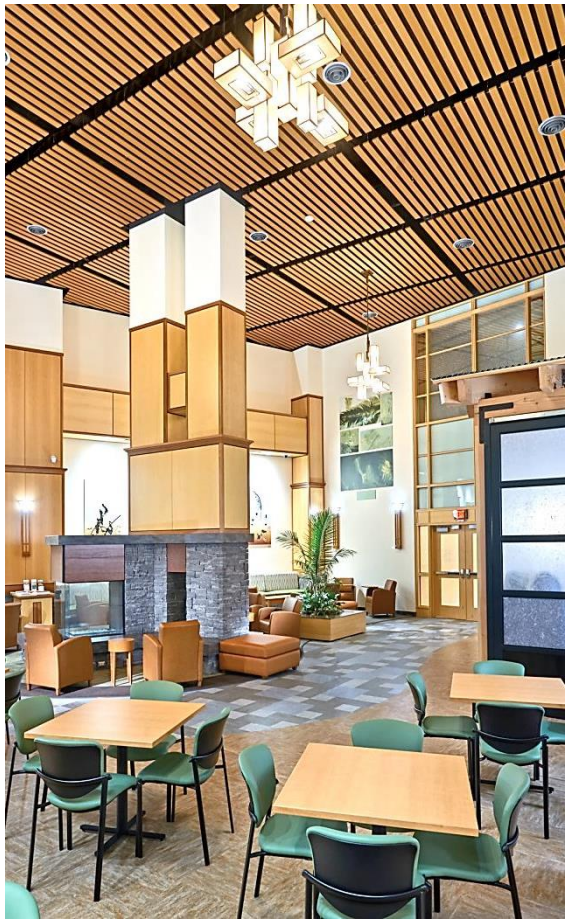
- Ceiling system NRC 0.65 would absorb 65 percent of the noise energy striking it.

CAC (Ceiling Attenuation Class): measures how well the material blocks sound transmission, noise traveling from one space to another.

- Ceiling system of less than 35 would be unable to achieve sound blocking that would deliver confidential speech privacy.
- The higher the CAC, the better. A CAC of 35 or greater represents high performance.

Acoustic Performance

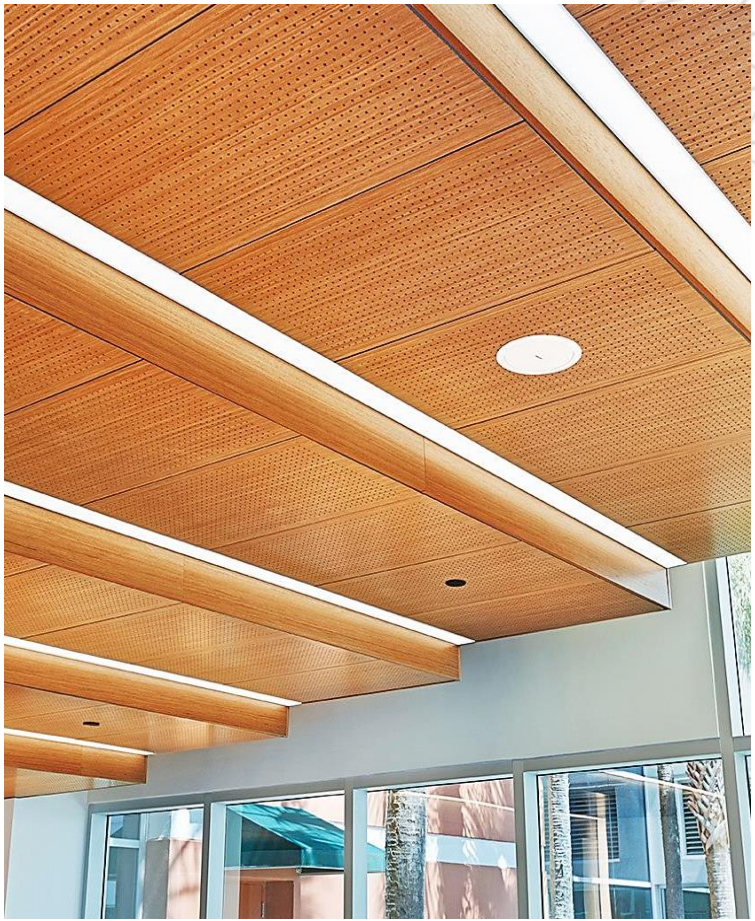
- **Higher NRC**: absorbs noise from bouncing back into the room, reduces noise levels and reverberation time, enhances speech intelligibility.
- **Higher CAC:** reduces noise from adjacent spaces, ensures speechprivacy, provides quiet for concentration and focus.



Acoustic Performance

Two most important strategies for improving the acoustic performance of wood ceilings generally work together:

- **Perforations** allow sound to penetrate the panel
- **Acoustical material** absorbs the sound energy.



Acoustic Performance

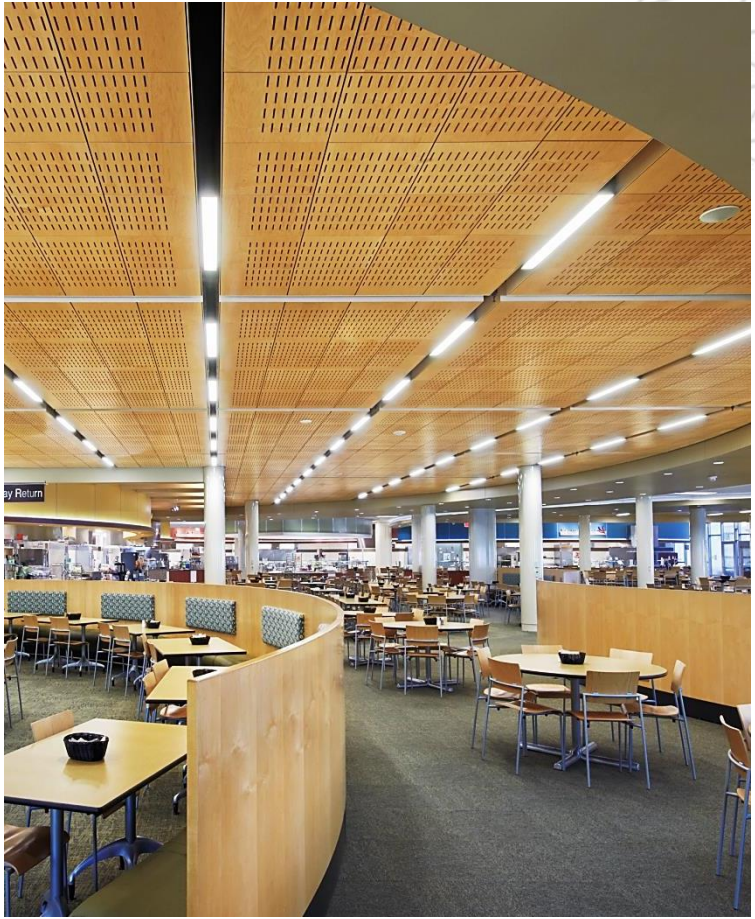
- Percentage of open area relates to acoustical absorption of the panels.
- NRC can range from: 0.15 with no acoustical backing to 0.85 for a 20 percent open panel with acoustical backing.
- Perforations: openings can be virtually invisible and still absorb significant sound striking panel surface.

Acoustic Performance

- Basic acoustical material is “fleece,” preferably composed of environmentally benign materials such as mineral and plant fiber.
- Factory-applied backing on panels
- Separate panels or infill

Acoustic Performance

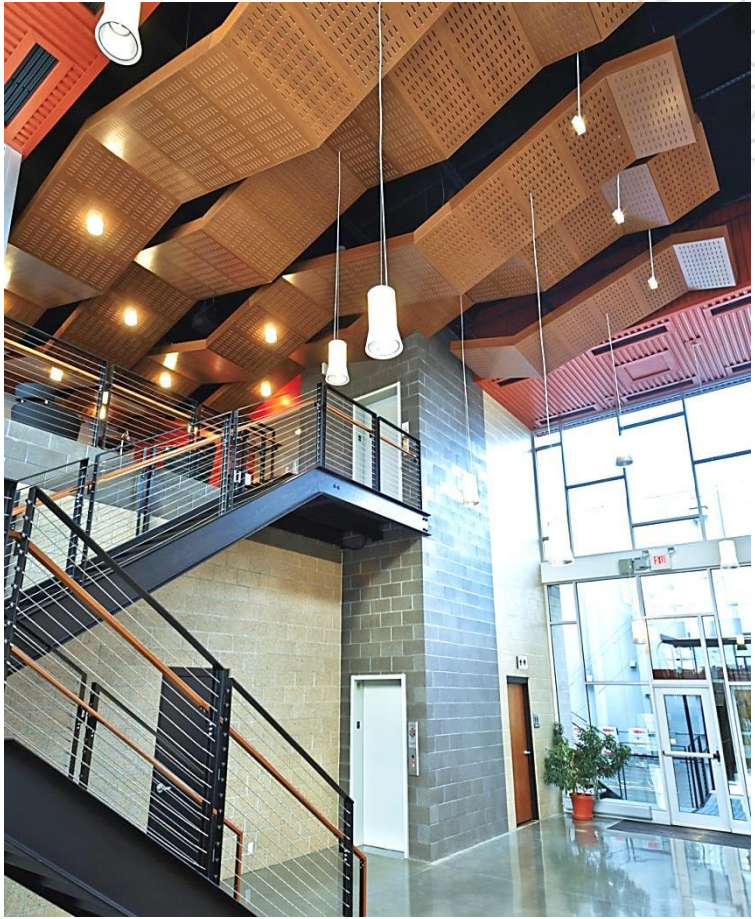
- Acoustical canopies, clouds can sometimes provide greater sound absorption than continuous ceiling of same surface.
- Sound absorbed from both front and back surfaces.



Acoustic Performance

- Here acoustical clouds suspended in sloped, ribbon-like pattern.
- Wood veneer panels add warmth, improve acoustics.
- Panels perforated in oval, straight-slotted pattern, backed with fiberglass infill.

Lyric Opera Administration Building, Kansas City, MO (Architect: Hu Jarvis Meyer Architects, Kansas City, MO)



Acoustic Performance

- College Football Hall of Fame: maintain theme, control noise from visitors.
- Hall of Fame room: channeled wall panels contribute to formal atmosphere and have acoustical backing with an NRC of 0.70.
- Theater: perforated linear panels installed in folded planes on walls and ceiling. Acoustical panels with an NRC of 0.90 are installed between the folds.

Fire Performance

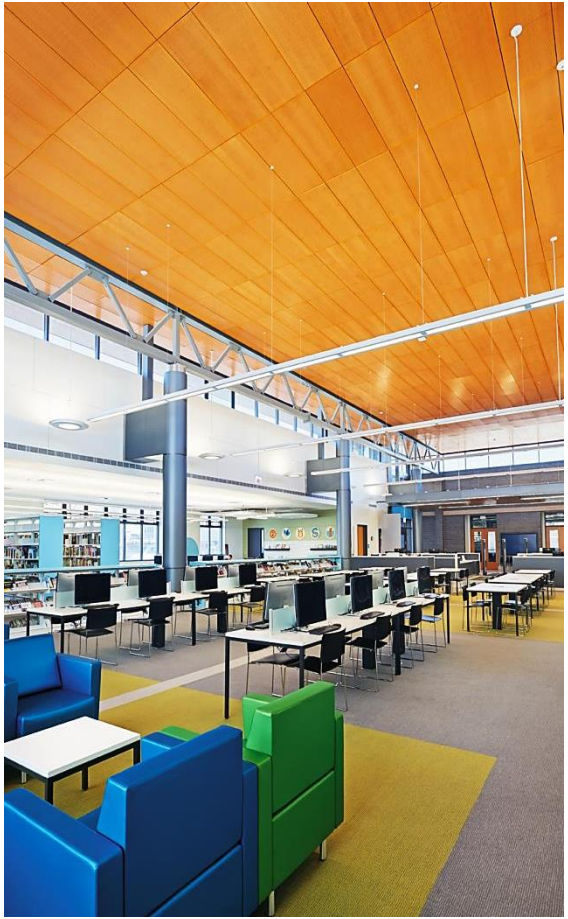
- Fire performance of wood is focus of intense research, product development, and testing.
- Wood walls and ceilings meet levels of fire ratings appropriate for applications in virtually all commercial interiors.

Fire Performance

- International Building Code (IBC) defines classifications for the flame spread and smoke development of a building material.
- Classifications based on material's test results: ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.

Fire Performance

- Class A (highest): flame spread ratings (FSI) of 25 or less.
- Many codes also require the smoke developed index rating (SDI) to be 50 or less.
- ASTM E1264, “Standard Classification for Acoustical Ceiling Products”: Class A products must have **both** FSI 25 or less ***and*** composite SDI 50 or less.
- National Fire Protection Association (NFPA) requires 25/50 performance for panels in a return-air plenum assembly.



Fire Performance

When evaluating manufacturer's product information:

- Make sure all references to codes are up to date.
- In ***all*** cases tests should be conducted on complete, assembled, composite panel: veneer fully adhered to substrate, using same adhesives final product.

Seismic Performance

- Seismic performance in wood ceilings primarily determined by installation of suspension system.
- Purpose of installation requirements for suspended ceilings were seismic performance is a factor:
  - Providing suspension system strong enough to resist lateral forces imposed upon it without failing.
  - Preventing border panels from falling from the ceiling plane.

Seismic Performance

- IBC: Seismic Design Category, designated A-F, must be established for each construction project based on anticipated ground motion, soil type in a specified geographic area and occupancy category.

Installation of ceilings based on designated Seismic Design Category:

- **Categories A & B**: ceiling installed to meet requirements in ASTM C636.
- **Category C** projects must meet ASTM C636, ***plus*** additional provisions listed in ASTM E580 for light to moderate seismic.
- **Categories D-F** must follow ASTM C636 ***and*** ASTM E580 for severe seismic.

Seismic Performance

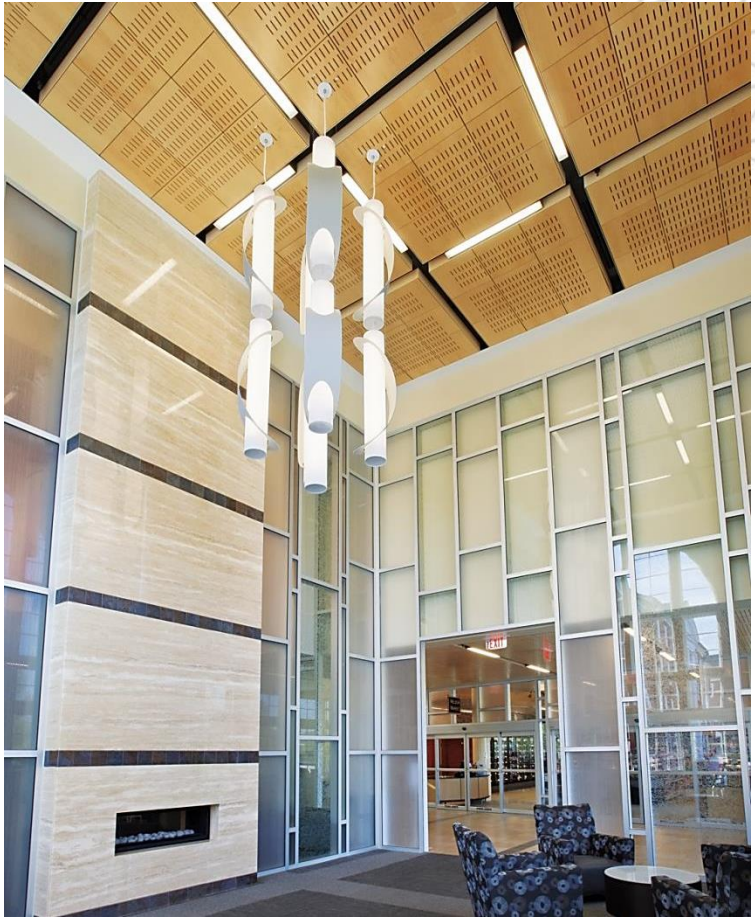
- Any panel weighing 2.5 pounds per square foot or more (which is most wood) must be installed per the additional stringent installation requirements of Seismic Design Category D, E, and F.
- Some jurisdictions, including the California Building Code, require wood or other hard or heavy panels to be positively attached to the suspension system.

Seismic Performance

- With high seismic risk, may be need for additional measures, e.g. specialized clips or safety cables to prevent heavy panels from falling during a seismic event.
- Working with a manufacturer who performs documented seismic performance testing is a major advantage in code compliance and streamlined installation.

Seismic Performance

- Integrated pre-engineered ceiling solutions can include tested suspension systems, all components, installation support.
- All from a single source.
- Can include range of options for:
  - veneer
  - surface configuration
  - acoustic performance
  - fire rating
  - accessibility
  - environmental features



Accessibility

- Ease of access to plenum a priority for building owners and managers.
- Equipment overhead is becoming increasingly complex.

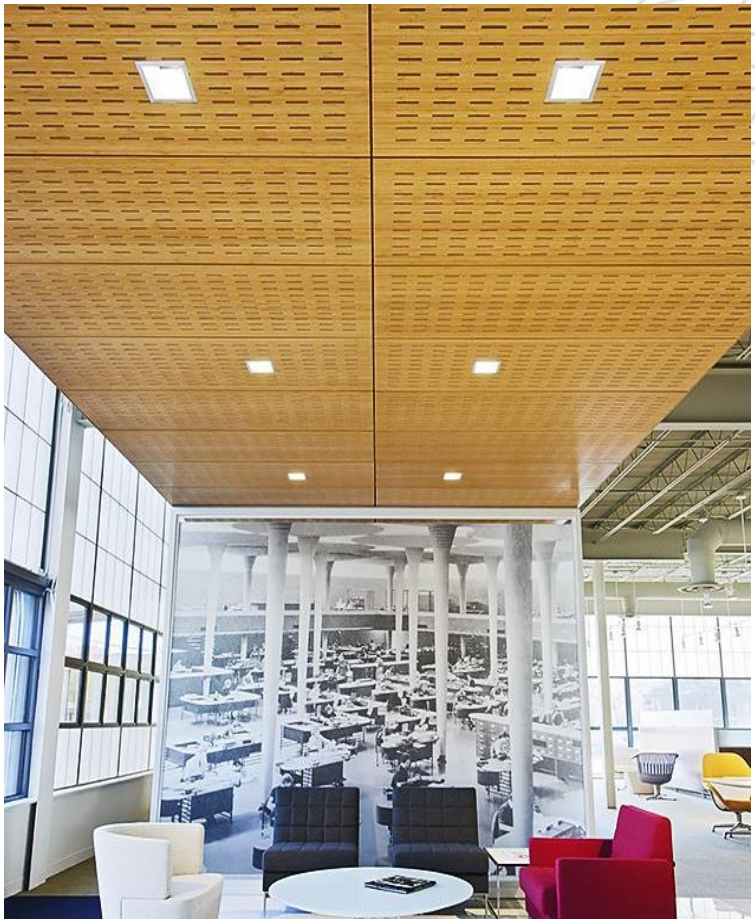
Accessibility

- Routine cleaning, servicing of many separate systems, lighting fixtures, ductwork, plumbing, air diffusers, fire protection, etc.
- New demands requiring easy accessibility for installation, maintenance, and updating new generations of cable and lighting technology and wireless access points.

Accessibility

- Suspended ceilings with flat panels, completely or partially concealing the space above, with "hook-on" installation provide removal of panels for full downward accessibility and are the most easy to install and the most economical.

Rockford Interiors, Austin, TX Architect: Dunnam Tita, Austin, TX



Accessibility

- More complex wood ceilings can also be designed for efficient access, including custom flat, radial, curved, torsion spring ceilings.
- New complete pre-engineered installation systems for accessibility, featuring same wide range of options.

Helen DeVos Children's Hospital, Grand Rapids, MI **Architect:** URS, Grand Rapids, MI

Accessibility

- Important basic questions to ask in early stages of design to achieve a safe, efficient, accessible wood ceiling:
- Anticipated frequency and type of access needed?
- Overall weight of the ceiling?
- Need for a special tool?

Accessibility

- Botanical Research Institute uses new pre-engineered integrated system to provide plenum access.
- Accessibility an important part of the building's sustainable design.
- Geothermal HVAC system, no large air handling units needed. Instead, numerous much smaller air handlers installed above the ceiling

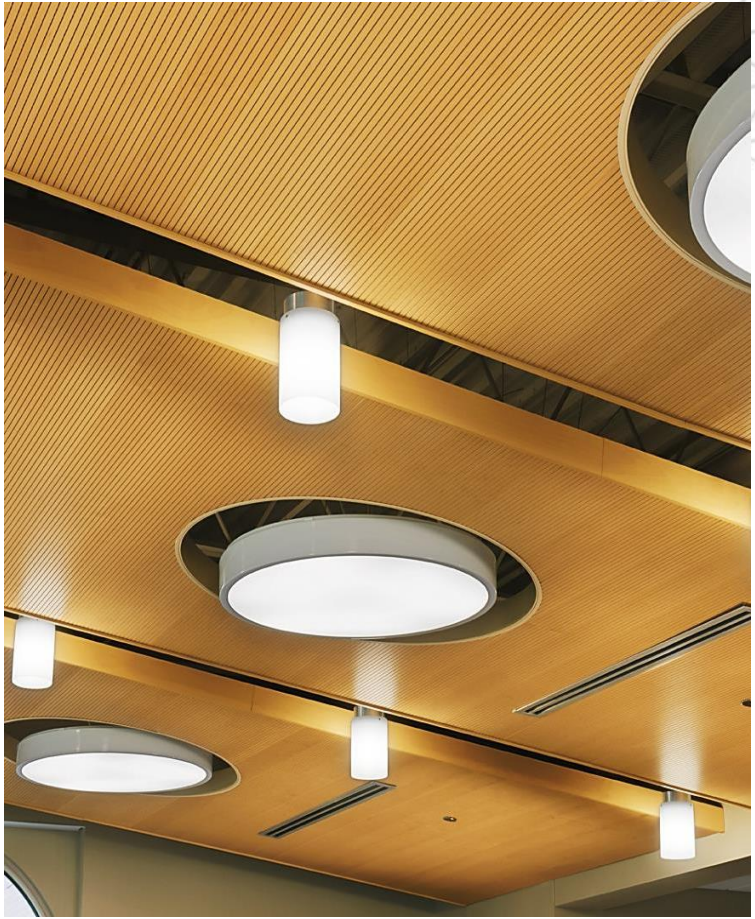
Moisture and Humidity Resistance

All wood panels are hygroscopic, meaning they respond to changing humidity levels. Wood must be acclimated to the space for 72 hours before installation.

"The space in which architectural woodwork is to be installed needs to be engineered with appropriate humidity controls to maintain its optimum relative humidity." *

- Range achievable with normal HVAC in operation:
  - Temperature: 50°F - 86°F (10°C - 30°C)
  - Relative Humidity: 25% – 55%

*North American Architectural Woodwork Standards NAAWS3.0 United States Version

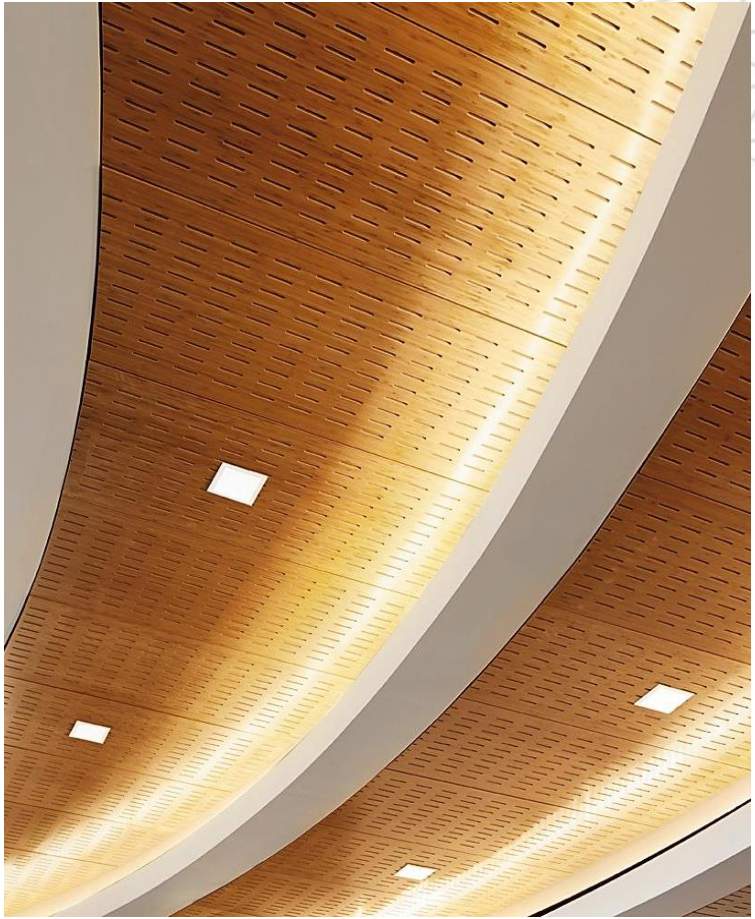


Moisture and Humidity Resistance

- Proper manufacturing of wood panels is important, directly affects ceiling's long term durability.
- Dimensional stability in a veneered panel achieved by matching species of the face and back veneers.
- If the veneer species on face and back do not match, they will react differently to humidity and can warp.

Sustainable Spaces

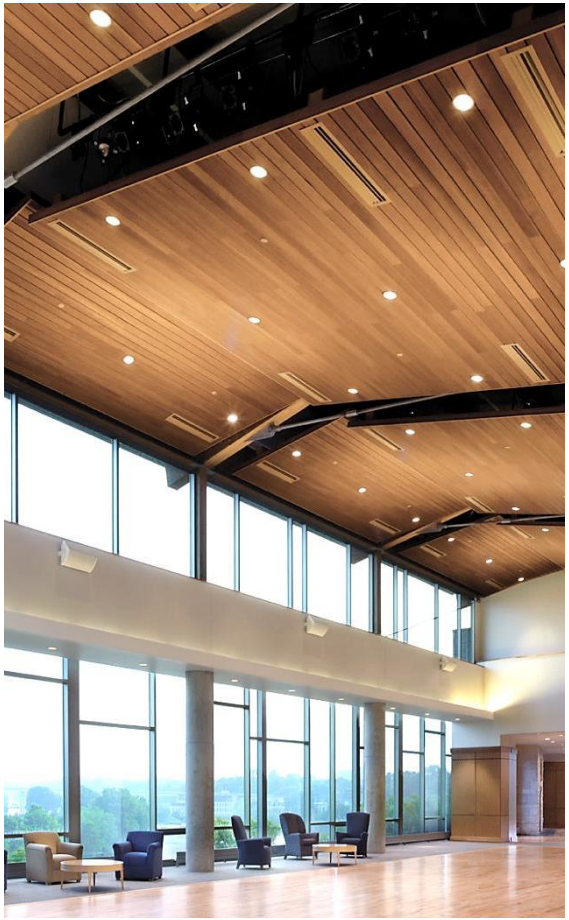
- Solid wood and bamboo veneer are inherently sustainable materials since they are a renewable resource, have low lifecycle costs, and a low carbon footprint.
- Reclaiming and re-purposing wood material results in positive environmental impact.
- Botanical Research Institute: wood materials were used to express a deep commitment to environmental excellence.
- LEED-NC Platinum project uses several types of wood and plant-based materials, including rapidly renewable, FSC-certified bamboo.



Sustainable Spaces

- In the Lawrence University-Richard and Margot Warch Campus Center FSC-certified wood in the ceiling systems contributed to LEED-NC 2009 Materials & Resources Credit 7.0 (Certified Wood).
- Facility awarded LEED-NC Gold, first higher education building in Wisconsin to achieve this level.

The Lawrence University-Richard and Margot Warch Campus Center, Appleton, WI (Architect: Uihlein-Wilson Architects, Milwaukee, WI; and KSS Architects, Princeton, NJ)



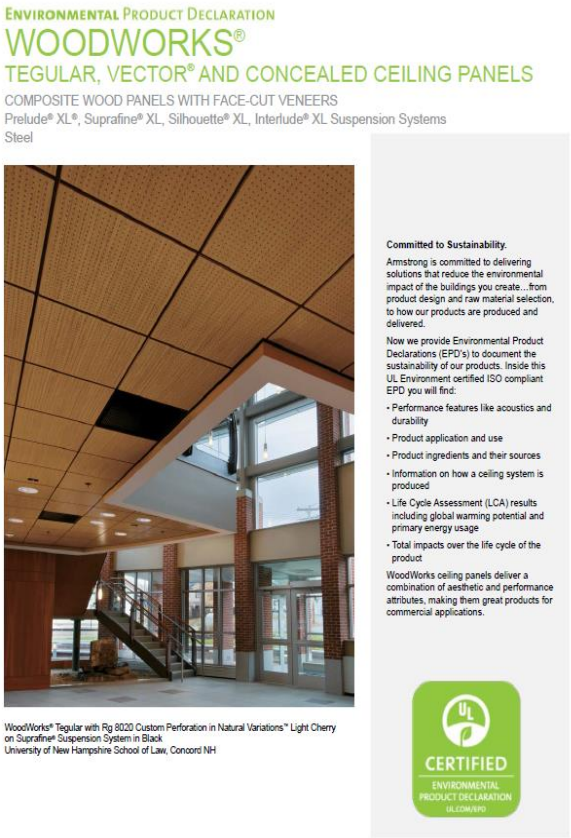
Major certifications for comparing wood ceiling and wall products:

- **Forest Stewardship Council®** (FSC): certification ensures that products come from responsibly managed forests through a verified chain of custody.
- **Rainforest Alliance**: certification that wood products are sourced from forests managed to protect endangered species, areas with high conservation value, workers and communities.

- **US Department of Agriculture BioPreferred:** certifies biobased products from plants and other renewable sources. More than 2,500 products in 100 different product categories listed on USDA website.
- **California Air Resources Board (CARB):** CARB Phase 2 certifies compliance with stringent formaldehyde emission levels for particleboard panels, MDF panels, and hardwood plywood panels.

Sustainable Spaces

- **Environmental Product Declarations**: standardized, internationally recognized, independently verified, comprehensive description of product's full environmental impact.
- **LEED:** Variety of natural substrate and veneer materials can make significant contribution to LEED credits.



ENVIRONMENTAL PRODUCT DECLARATION

WOODWORKS®

TEGULAR, VECTOR® AND CONCEALED CEILING PANELS

COMPOSITE WOOD PANELS WITH FACE-CUT VENEERS

Prelude® XL®, Suprafine® XL, Silhouette® XL, Interlude® XL Suspension Systems

Steel

WoodWorks® Tegular with Rg 8020 Custom Perforation in Natural Variations™ Light Cherry on Suprafine® Suspension System in Black
University of New Hampshire School of Law, Concord NH

Committed to Sustainability.

Armstrong is committed to delivering solutions that reduce the environmental impact of the buildings you create…from product design and raw material selection, to how our products are produced and delivered.

Now we provide Environmental Product Declarations (EPD's) to document the sustainability of our products. Inside this UL Environment certified ISO compliant EPD you will find:

- Performance features like acoustics and durability
- Product application and use
- Product ingredients and their sources
- Information on how a ceiling system is produced
- Life Cycle Assessment (LCA) results including global warming potential and primary energy usage
- Total impacts over the life cycle of the product

WoodWorks ceiling panels deliver a combination of aesthetic and performance attributes, making them great products for commercial applications.

CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

- **LEED 2009**
  - Recycled Content (MRc4)
  - Regional Materials, dependent on project location (MRc5)
  - Rapidly Renewable Materials (MRc6)
  - Certified Wood (MRc7)
  - Low Emitting Materials – Composite Wood (EQc4.4)

- **LEED v4**
  - Regional Materials (MR credits)
  - Building Life Cycle Reduction, Interiors Life Cycle Impact Reduction (MRc BD&C, MRc ID&C)
  - Building Disclosure and Optimization – EPD

    (MRc BD&C, MRc ID&C)

Installation and Integration

- Proper installation determines ultimate design and performance.
- Safety features like seismic compliance, and fire resistance rely directly on proper installation.
- More complex: unique sizes and shapes, sloped, curved or faceted ceilings, transitions between wood ceilings and walls.

Installation and Integration

- **Standard**: veneered panels, hung from standard suspension system with specialized hook-on panels provide safe and secure downward accessibility.
- Panels with factory-applied fleece or infill panels available as options.

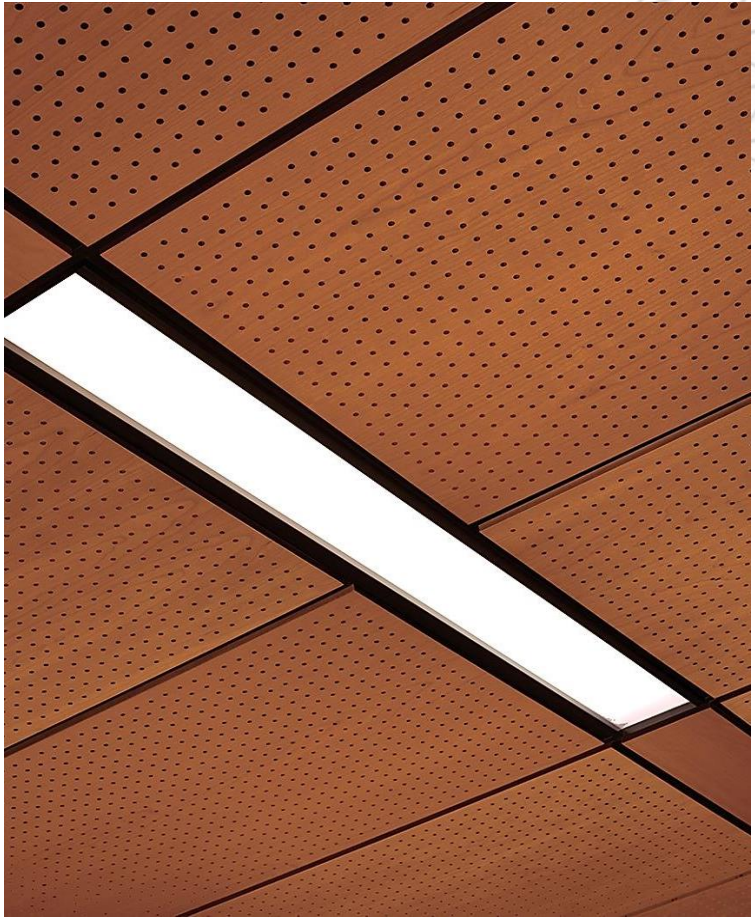
La-Z -Boy Furniture Headquarters, Monroe, MI Architect: The Collaborative Ann Arbor MI

- **Custom** installation systems can implement the most imaginative designs.
- In the Lyric Opera Administration Building lobby, custom splice plates and grid clips used to create 30-degree angles in the clouds.

Installation and Integration

- Taking both standard and custom installation one step further: **pre-engineered integrated ceiling systems** can provide:
  - Different levels of acoustic performance
  - Pre-testing for seismic performance
  - Complete accessibility for complex ceiling installations

- Built-in compartments for “technical zones.



How Manufacturing Affects Cost and Performance

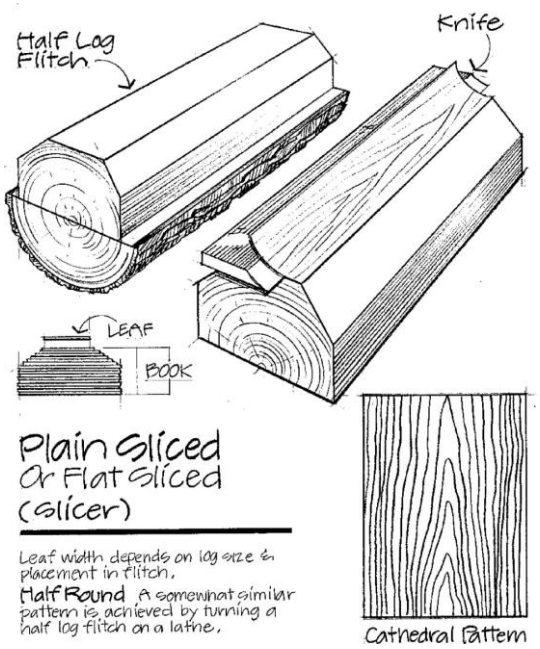
- Understanding how a wood panel is manufactured is useful to seeing both possibilities and limitations.
- Virtually every step has direct impact on how panels will look and perform.
- Before the production of custom system even begins, architect approves shop drawings.

Source Hundreds of sheets of veneer can be sliced from a single log. Visual characteristics of every tree are slightly different.

- “Flitch”: one set of veneer sheets from same tree.
- Manufacturers typically maintain inventories of flitches of frequently used veneers.

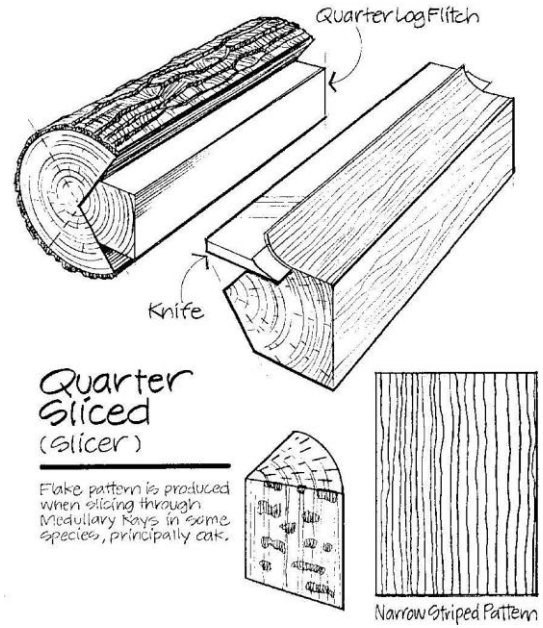
Veneer Cut Plain Sliced

- This is the slicing method most often used to produce veneers for high quality architectural woodworking.
- A combination of cathedral and straight grain patterns results, with a natural progression of pattern from leaf to leaf.



Veneer Cut Quarter Sliced

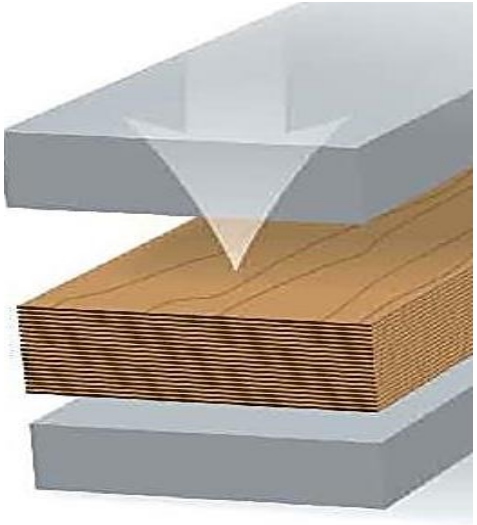
- Quarter slicing simulates the quarter sawing process of solid lumber, roughly parallel to a radius line through the log segment.
- In many species the individual leaves are narrow as a result.



"Flake" is a characteristic of this slicing method most commonly in red and white oak.

Reconstituted Veneer

- Reconstituted veneer (also referred to as recon) is a veneer made from vertically stacking flitches and laminating them together with a press.
- The edge of the laminated block becomes the grain, providing a more consistent, straight pattern than other veneers.



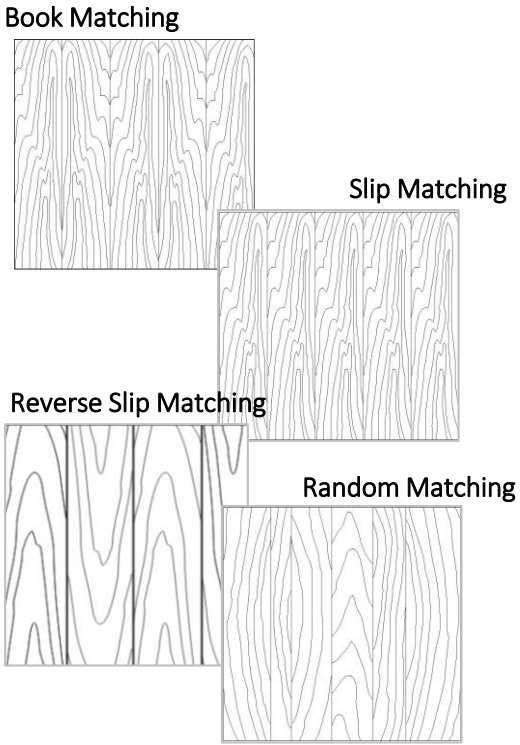
Veneer Press

Matching

- Leaf matching (often referred to as just matching): After the log is sliced, the stack of veneer leaves need to be placed side-by-side to create veneer faces.
- The way in which the individual cuts are placed next to each other during fabrication of the veneer face can effect the overall look of the sheet.

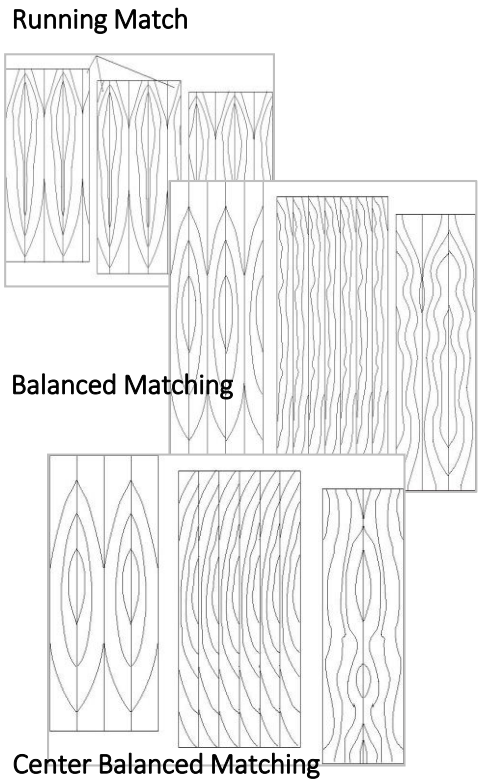
The main types of leaf matching are:

- Book matching
- Slip matching
- Reverse slip matching
- Random matching



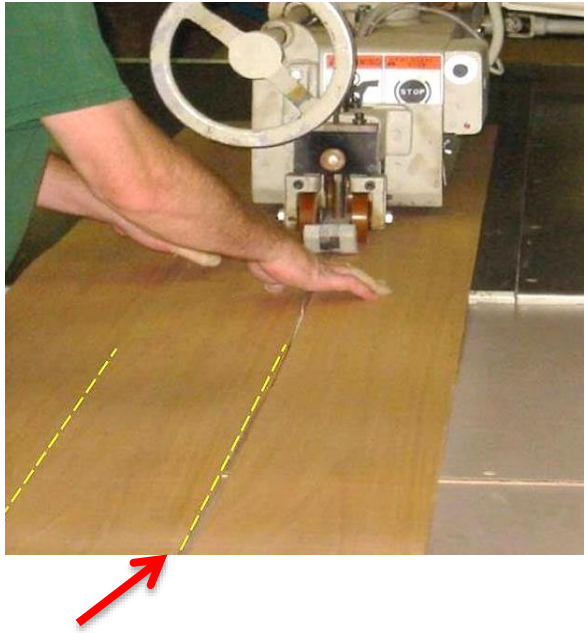
Attribute – Panel Face Matches

- In addition to how the leaves are sequenced, the way they are laid out on the panel face also has an impact on the overall visual.
  - Do the leaf widths vary or are they the same?
  - Are they centered on the panel?
- Three main panel matches:
  - Running
  - Balance
  - Center balance



Splicing of the veneer Veneer leaves are typically narrow. Sheets of veneer are spliced together to make larger sheets.

- How these sheets are laid out affects how the panel will look in the space.
- After splicing, each sheet of veneer is carefully inspected.



- **Application of veneer to substrate** Heat-activated adhesives bond the two together as they pass through the oven press.
- **Perforation** Panels trimmed to size. Edge-banding improves looks and performance. Acoustic perforations added using either multiple drilling units, or CNC (Computer Numerical Control).

How Manufacturing Affects Cost and Performance

- **Curving of panels** Panels gently formed into shape using mold or template and vacuum system. Preferable to curving panels in the field.
- **Finishing Line** Panels are prepared for staining by brushing and sanding the surface to consistent level. Key step in process: any imperfections will be highlighted when stain is applied.

Staining: Stain applied via mechanized spray heads, to produce even, consistent coat.

- Some panels require only clear-coat over natural finish, with no stain applied.
- Factory finishing of panels is critical to fire performance.
  - In contrast, millwork often finished with low cost varnishes applied by hand, makes performance impossible to predict.

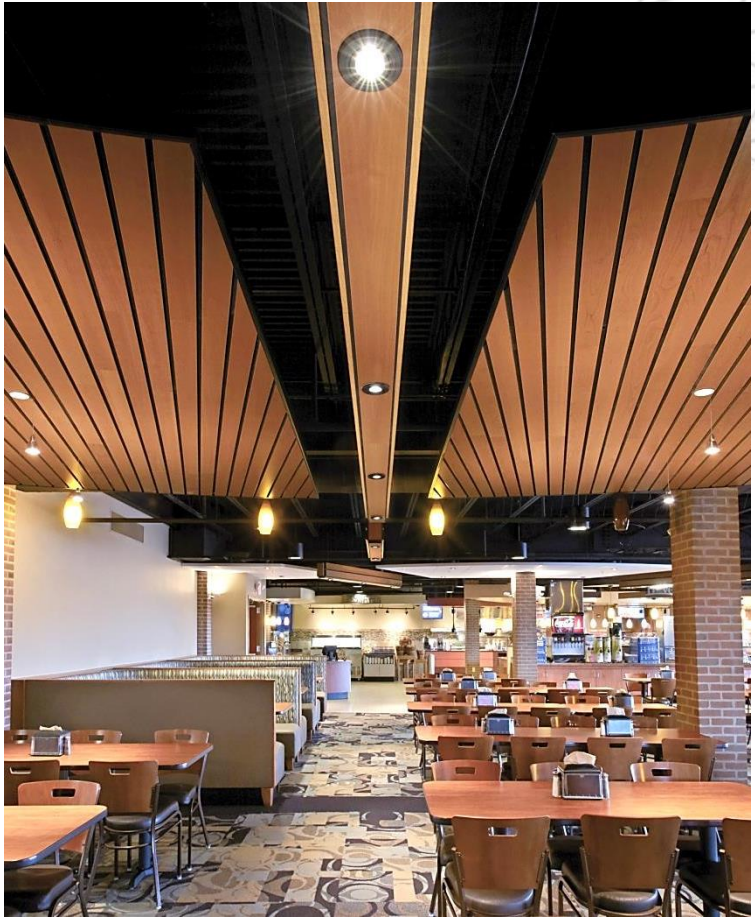
Stain Application

Packaging: Finished panels are carefully packed to ensure damage-free delivery to the jobsite.

Early planning ensures good results and cost efficiency.

Basic first steps include decisions about:

- Specific performance needs.
- Option of using standard components to achieve custom looks
- Ability to create a one-of-a-kind visual to support your design vision



Manufacturer should be able to:

- Demonstrate state of the art manufacturing capabilities, quality control.
- Exchange information easily: design details, preliminary drawings, reflected ceiling plans, section cuts, perimeter details.
- Support writing, reviewing specification before project goes to bid.

Summary: Delivering Performance

Wood specialty ceilings and walls bring the beauty and natural character of wood into virtually any design.

Integrated pre-engineered systems deliver predetermined performance levels in areas most important for health, safety and productivity:

- Excellent acoustics
- Safe spaces with tested fire and seismic performance
- Durable and easy to maintain spaces, moisture-resistant and accessible
- Healthy, sustainable spaces, good air quality and low negative impact on the environment

Thank You

This concludes the continuing education unit on wood ceilings and walls.

Thank you for your interest in Armstrong Ceiling and Wall Solutions.

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