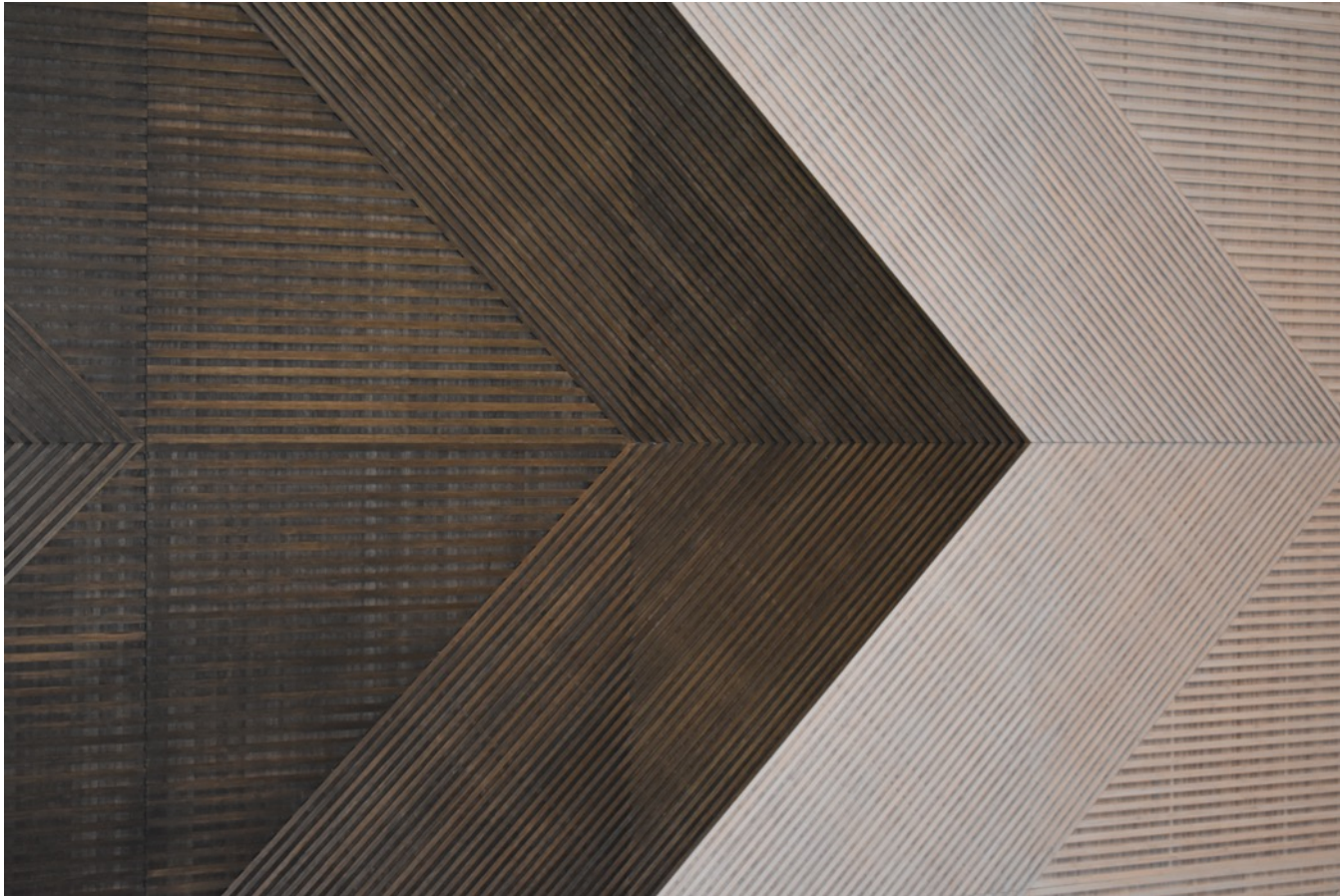


Architectural Bamboo in the Age of Digital Fabrication



The American Institute of Architects | Continuing Education Series

Author: Smith & Fong Company  SMITH & FONG

Course # AIA475

Architectural Bamboo in the Age of Digital Fabrication



The American Institute of Architects | Continuing Education Series
Author: Smith & Fong Company



- **San Francisco Based Manufacturer of Sustainable building materials in Bamboo and Palm.**
- **Founded in 1989, we were early pioneer in the development of the bamboo lamination process.**
- **First Manufacturer to create Bamboo Plywood “Plyboo”, and first company to bring bamboo flooring to the American market in 1993.**
- **First to achieve FSC certification for Bamboo Plywood and Flooring in 1996.**
- **First to achieve Life Cycle Analysis for Bamboo and EPD 2017.**



LEARNING OBJECTIVES

1. Understand the manufacturing process, construction and environmental properties (Life Cycle Analysis) of architectural bamboo panel.
2. Understand the set-up, tooling and machinery and techniques associated CNC milled bamboo panels.
3. Understand the process of fire rating and manufacturing acoustical products utilizing CNC milled architectural grade bamboo panels.
4. Understanding specify CNC milled bamboo panels including environmental , fire rating, acoustical and architectural grade bamboo requirements.

PROGRAM REGISTRATION

McGraw Hill construction is a registered provider with the American institute of architects continuing education systems. Credit earned on completion of this program will be reported to CES Records for AIA members. Certificated of completion for non-AIA members are available.

This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product. Questions related to specific materials, methods and services will be addressed at the conclusion of this presentation.



GENERAL FACTS

- 1300 species of bamboo
- Grows through the world in a wide range of environments
- Sizes range from shrub to 120 feet
- Grows rapidly, reaching rate of 1 inch per hour
- Sequesters up to 70% more carbon per year than a hardwood forest (source: World Wildlife Fund)



MOSO BAMBOO: FORESTRY



MOSO BAMBOO: FORESTRY



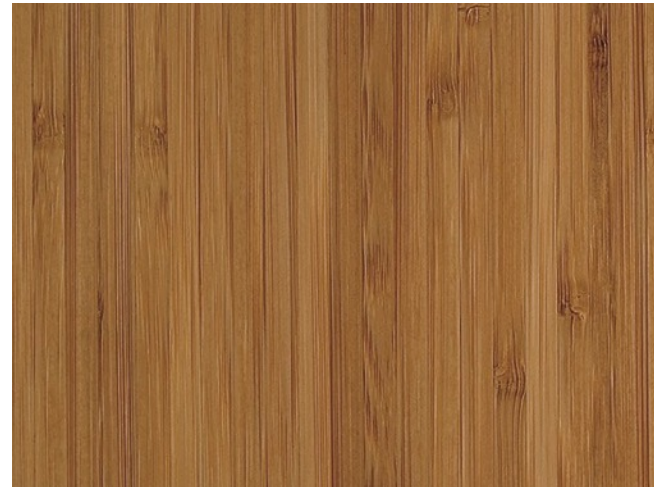
MOSO BAMBOO FORESTRY



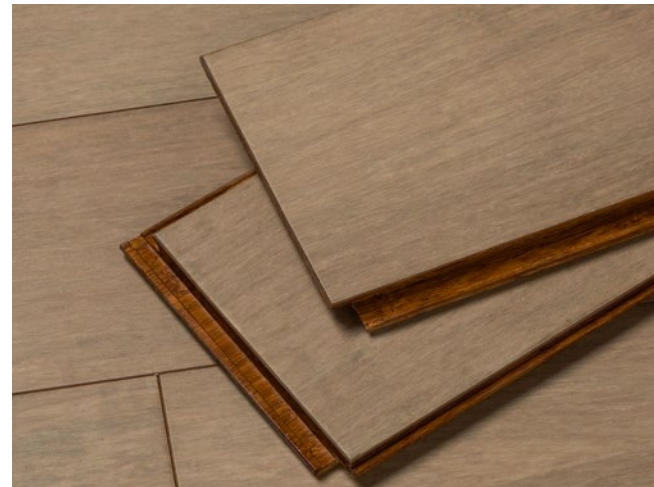
BAMBOO MANUFACTURING



BAMBOO LAMINATION



BAMBOO STRAND



LEED CREDITS

- **US GREEN BUILDING COUNCIL'S LEED 3.0**
 - **MRc6: Rapidly Renewable Materials**
 - **MRc7: Certified Wood and Bamboo**
 - **IEQc4.4: Low Emitting Materials (Plywood and Veneer)**
 - **IEQc4.3: Low Emitting Materials (Floor Score Certified)**
- **LEED 4.0**
 - **MRc4 Material Ingredients: Disclosure and Optimization**

Disclosure: An HPD can contribute as a floor, wall, ceiling or furniture material to the 20 products from at least 5 manufacturers that are required to achieve 1 point in this area.
 - **MRc2 Environmental Product Declarations: Disclosure and Optimization**

Disclosure: An EPD (3rd-party verified, product-specific EPD worth full credit) can contribute as a wall, ceiling or furniture material to the 20 products from at least 5 manufacturers that are required to achieve 1 point in this area.
 - **MRc3 Sourcing of Raw Materials Disclosure and Optimization**

Disclosure: FSC certified products can contribute as a floor, wall, ceiling or furniture material to the 20 products from at least 5 manufacturers that are required to achieve 1 point in this area.

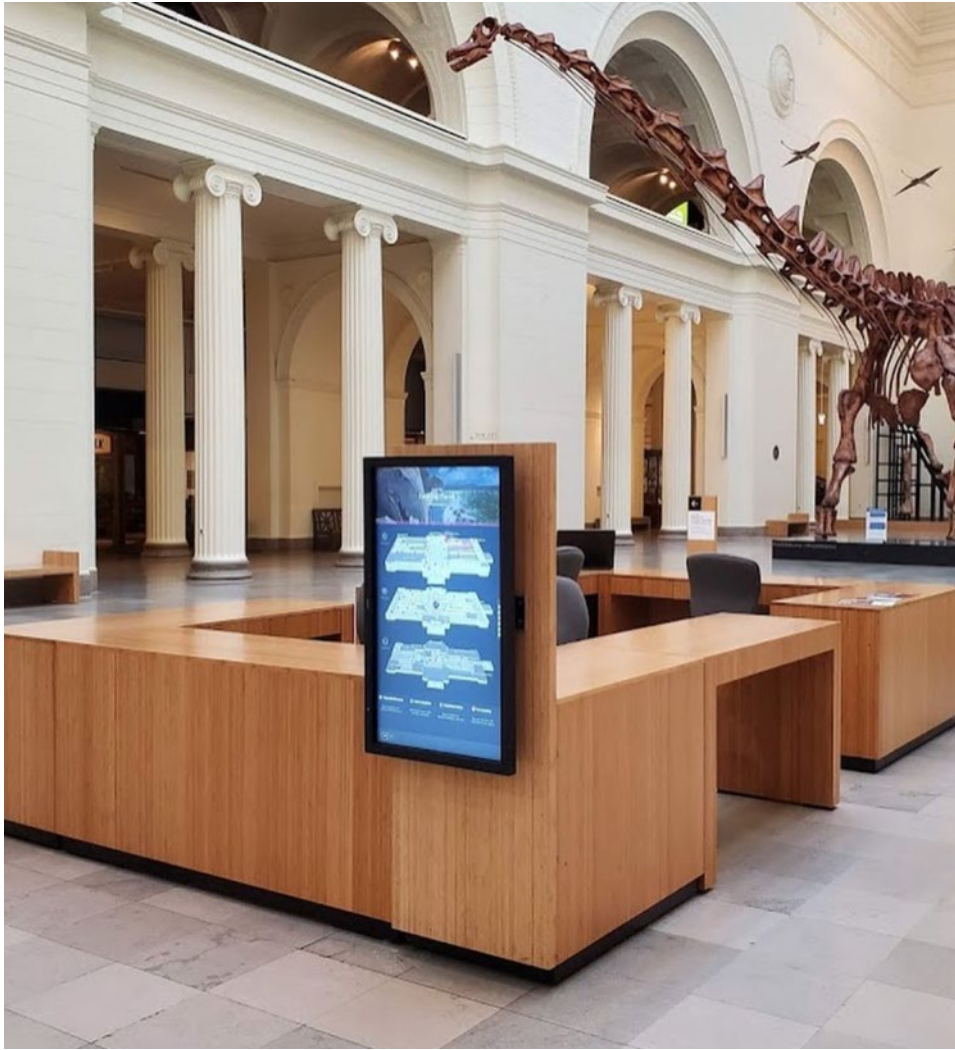
WALL PANELS



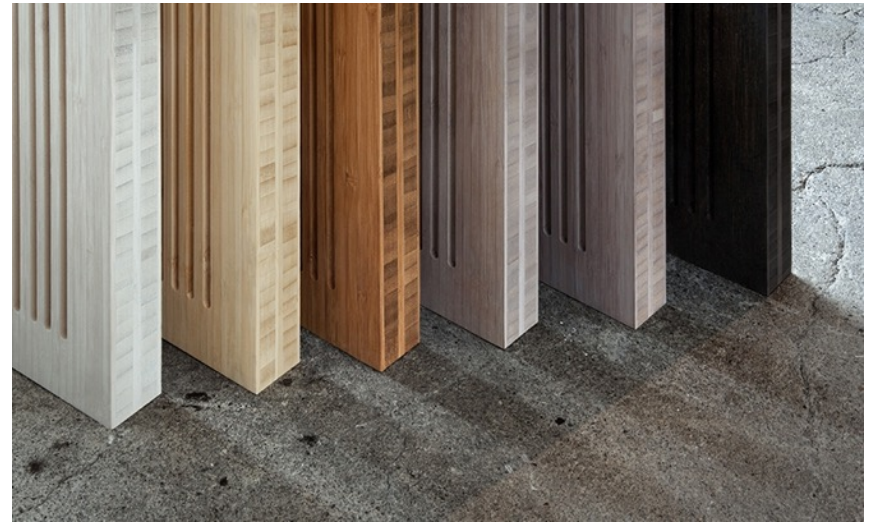
WALL PANELS



CABINETS AND MILLWORK



DOORS



DOORS | WALLS



PERFORATED WALLS | CEILINGS



PERFORATED CEILINGS



DIVIDERS | LOBBIES



FURNITURE





BENEFITS OF ARCHITECTURAL BAMBOO PLYWOOD

- **Bamboo Plywood that is cross laminated provides excellent stability and does not require edge banding**
- **Bamboo Plywood that is manufactured for the sole purpose of routing and therefore consistent in color and without voids**
- **Bamboo Plywood that is manufactured with a 3mm face and balanced allows for a durable wear layer ideal for commercial applications**
- **Bamboo Plywood that is pre-sanded and pre-finished is easier to work with and installation ready.**
- **When carved, an interplay between the face layer and revealed inner core creates a stunning visual effect.**

CNC ROUTERS

FORM AND FUNCTION

- **CNC router (Or Computer Numerical Control router) is a computer-controlled cutting machine related to the hand held router used for cutting various hard materials, such as wood, composites, aluminum, steel, plastics, and foams. CNC stands for computer numerical control.**
- **A CNC router typically produces consistent and high-quality work and improves factory productivity.**
- **Unlike a jig router, the CNC router can produce a one-off as effectively as repeated identical production. Automation and precision are the key benefits of CNC router tables.**

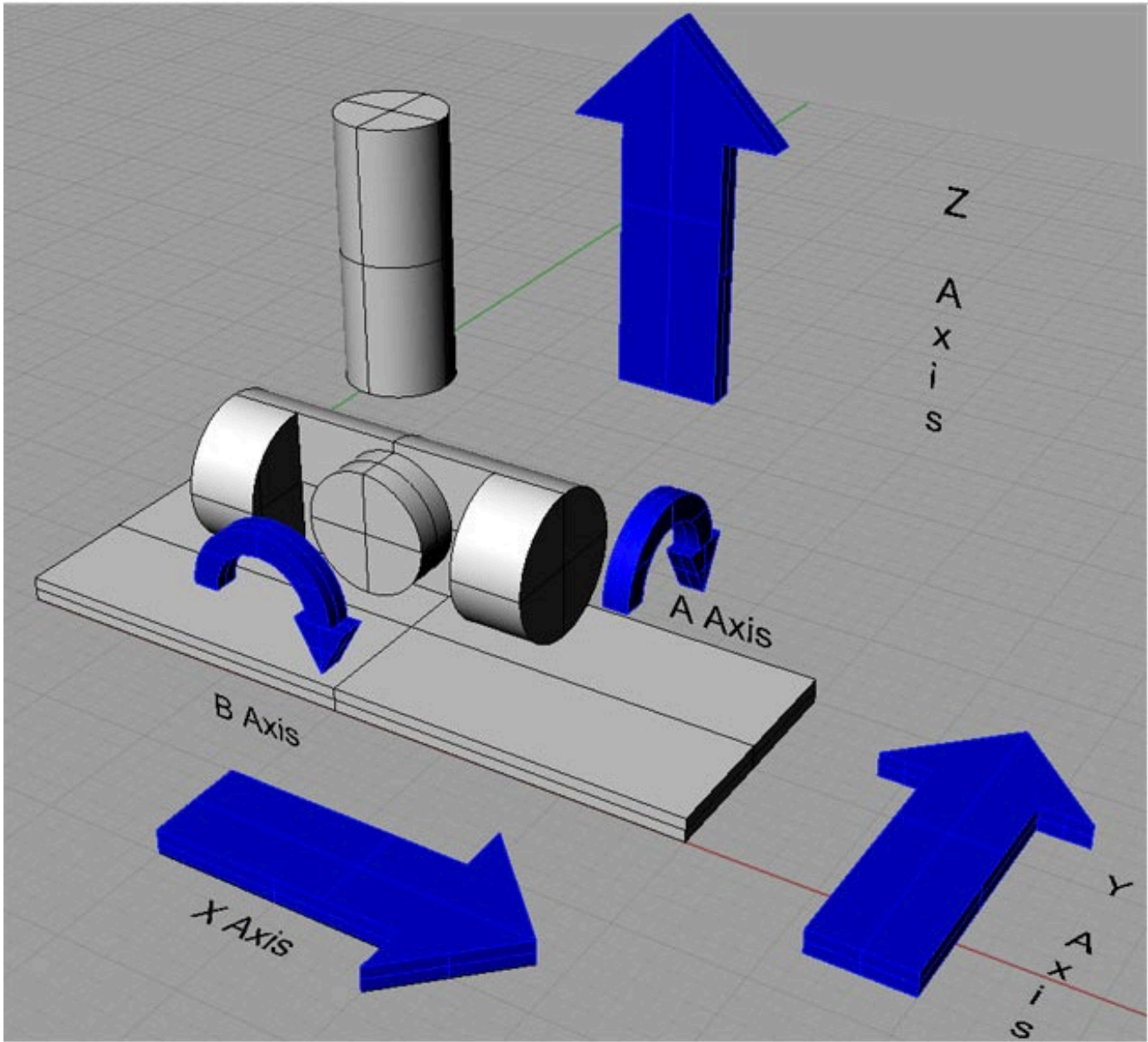
CNC ROUTERS

FORM AND FUNCTION

- Computer driven routing machine that provides precise multi-axis carving of many materials by introducing a knife to a material that is secured to a vacuum secured bed.
- Depending on its level of sophistication, CNC Machines are able to cut on 3 or 5 axis's (examples of cutting on axis)
- 5 axis machines while more expensive can offer more complex and dimension cutting













CAUTION
HANDS OFF
WHEN MACHINE IS
OPERATING



BAMBOO PANELS AND CNC ROUTING

Once carved, these panels reveal the multiple layers and strips that it is constructed from.



COLORATIONS AND STAINS

(Examples)

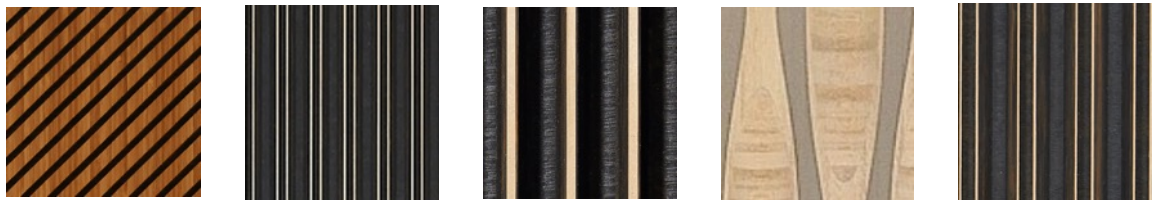
Naturally Achieved Colors



Applied Stain Colors



**Duo Tone Coating
Color Process**



Duo Tone Naturals



FIRE RATING



CLIENT: SMITH & FONG
Test Report Number : RJ4943-3
Date: September 2, 2016
Page 4 of 7

SUMMARY OF ASTM E84 RESULTS:

Because of the possible variations in reproducibility, the results are adjusted to the nearest figure divisible by 5. Smoke Density values over 200 are rounded to the nearest figure divisible by 50.

In order to obtain the Flame Spread Classification, the above results should be compared to the following table:

<u>NFPA CLASS</u>	<u>IBC CLASS</u>	<u>FLAME SPREAD</u>	<u>SMOKE DEVELOPED</u>
A	A	0 through 25	Less than or equal to 450
B	B	26 through 75	Less than or equal to 450
C	C	76 through 200	Less than or equal to 450

BUILDING CODES CITED:

1. National Fire Protection Association, ANSI/NFPA No. 101, "Life Safety Code"
2. International Building Code, Chapter 8, Interior Finishes, Section 803.

ASTME
84
CLASS A
(Bamboo
Strand
Core)



FIRE RATING

CLIENT: **SMITH & FONG**
475 6th Street
San Francisco, CA 94103

Test Report Number : RJ4943-2	Date: September 2, 2016
---	---------------------------------------

SAMPLE ID: The client identified the following test material as:
Plyboo Linear 4. Thickness: 3/4 " inch. (See photo in Appendix)

SAMPLING DETAIL: Test Samples were submitted to the Laboratory directly by the client. No sampling or sample preparation were observed by QAI staff.

DATE OF RECEIPT: Samples were received at QAI facilities on: August 25, 2016

TESTING PERIOD: August 31, 2016.

AUTHORIZATION: Testing was authorized by for proposal 16MB08052R1 signed August 5, 2016

TEST REQUESTED: Perform standard flame spread and smoke density developed classification tests on the sample supplied by the Client in accordance with ASTM Designation E84-16, "Standard Method of Test for Surface Burning Characteristics of Building Materials". The foregoing test procedure is comparable to UL 723, ANSI/NFPA No. 255, and UBC No. 8-1.

TEST RESULTS:	<u>Flame Spread</u>	<u>Smoke Developed</u>
	20	30

CONCLUSION: When tested in accordance to ASTM E84-16 the tested material resulted in a Class 'A'. Detailed test results are presented in the subsequent pages of this report

ASTME
84
CLASS B
(Bamboo
Ply Core)



FIRE RATING

CLIENT: **SMITH & FONG**
475 6th Street
San Francisco, CA 94103

Test Report Number : RJ4943-3	Date: September 2, 2016
---	---------------------------------------

SAMPLE ID: The client identified the following test material as:
Plyboo Liner Line 7. Thickness: 3/4 " inch. (see photo in Appendix)

SAMPLING DETAIL: Test Samples were submitted to the Laboratory directly by the client. No sampling or sample preparation were observed by QAI staff.

DATE OF RECEIPT: Samples were received at QAI facilities on: August 25, 2016

TESTING PERIOD: August 31, 2016.

AUTHORIZATION: Testing was authorized by Stacy Willard for proposal 16MB08052R1 signed August 5, 2016

TEST REQUESTED: Perform standard flame spread and smoke density developed classification tests on the sample supplied by the Client in accordance with ASTM Designation E84-16, "Standard Method of Test for Surface Burning Characteristics of Building Materials". The foregoing test procedure is comparable to UL 723, ANSI/NFPA No. 255, and UBC No. 8-1.

TEST RESULTS:	<u>Flame Spread</u>	<u>Smoke Developed</u>
	65	105

* Note: Due to excessive heat production, the test was terminated early as noted. Had the test continued for the normal 10 minute period, the flame spread value would have remained unchanged. The Smoke value has been estimated based on the last reading

CONCLUSION: When tested in accordance to ASTM E84-16 the tested material resulted in a Class 'B'. Detailed test results are presented in the subsequent pages of this report

FIRE RATING



CLIENT: SMITH & FONG
Test Report Number : RJ4943-3
Date: September 2, 2016
Page 4 of 7

SUMMARY OF ASTM E84 RESULTS:

Because of the possible variations in reproducibility, the results are adjusted to the nearest figure divisible by 5. Smoke Density values over 200 are rounded to the nearest figure divisible by 50.

In order to obtain the Flame Spread Classification, the above results should be compared to the following table:

<u>NFPA CLASS</u>	<u>IBC CLASS</u>	<u>FLAME SPREAD</u>	<u>SMOKE DEVELOPED</u>
A	A	0 through 25	Less than or equal to 450
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BUILDING CODES CITED:

1. National Fire Protection Association, ANSI/NFPA No. 101, "Life Safety Code"
2. International Building Code, Chapter 8, Interior Finishes, Section 803.



Newcastle
LIFE

Newcastle
LIFE



CARVING GUIDELINES SPECIFIC TO BAMBOO PANELS

- Panels can be carved primarily with the grain and may be carved against the grain in some cases.
- Graphic imagery, linear, sculptural and perforated carving are all possible.
- Up to 50% of material can easily be removed from panels without losing material integrity.
- Highly flexible, material will conform to a radius of up to 2'



BAMBOO PANELS AND CNC ROUTING

- **Bamboo Panels** manufactured specifically for carving will have consistent color, without voids and may contain any combination of cores and faces.
- Material may easily be customized due to various carving, stacking and coloration techniques



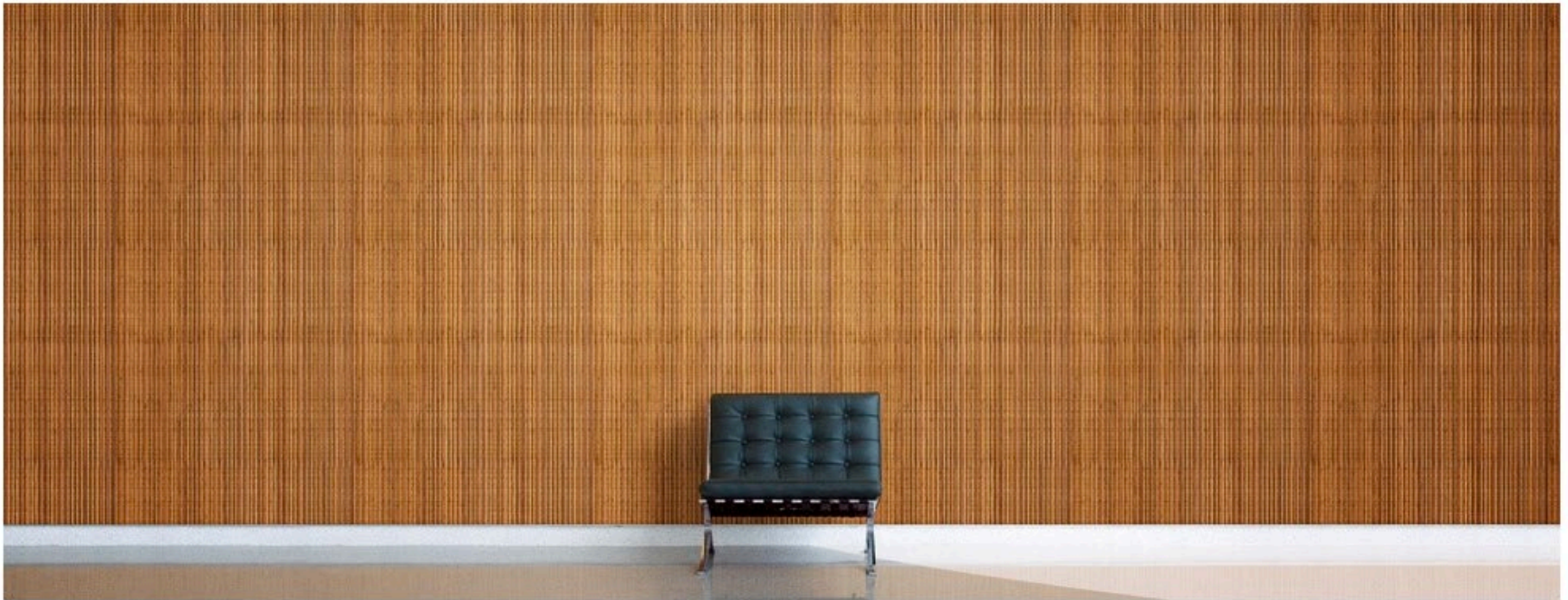


CARVING GUIDELINES SPECIFIC TO BAMBOO PANELS

- Radius inside corners as well as hard corners are possible
- Varied depth up to 1/2" and widths are possible as little as 1/4"
- Panels may be stacked to many times their size to create greater mass.
- Custom patterns are often just as fast or cost effective achieve as standard options due to cost being relative to time on the CNC
- Consider "scaling up" patterns to control cost

**MATERIAL+
FABRICATION
COST**

- **Non carved bamboo Plywood:
Approx \$6 per SF**
- **Organically carved and linear non
perforated: Approx \$25-27 per SF**
- **Perforated, Acoustical Panels:
Approx \$35-\$45 per SF**
- **Modular Design System: Approx.
\$35 per SF**



Product Info

Specs

Video

Linear Line Panel Style LL5

Specifications

[CSI 3-part specification - Linear Line Collection](#)

Core Composition: RealCore™ Technology

Color: Amber

Material: 100% Bamboo

Size: 3/4" x 47 3/4" x 95 3/4"

Metric: 19mm x 1213mm x 2432mm

Weight: 90 lbs

Surface Texture: Prefinished or Unfinished

Fire Resistance Classification: Class C (**Class B available**)

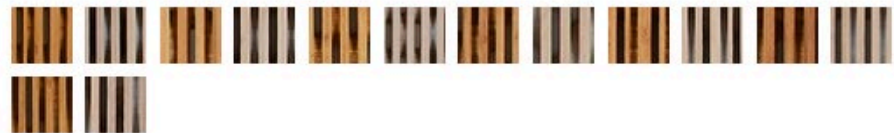
Emission Testing: ASTM-D6007-02: Formaldehyde Concentration in air from Wood Products, small chamber testing

Result: 0.004ppm (surpasses CARB II standards of 0.05ppm and ULEF standards of 0.04ppm)

BP-V4896RN/LL5

[Installation Guide](#)

Linear Sound Collection



Sound Collection

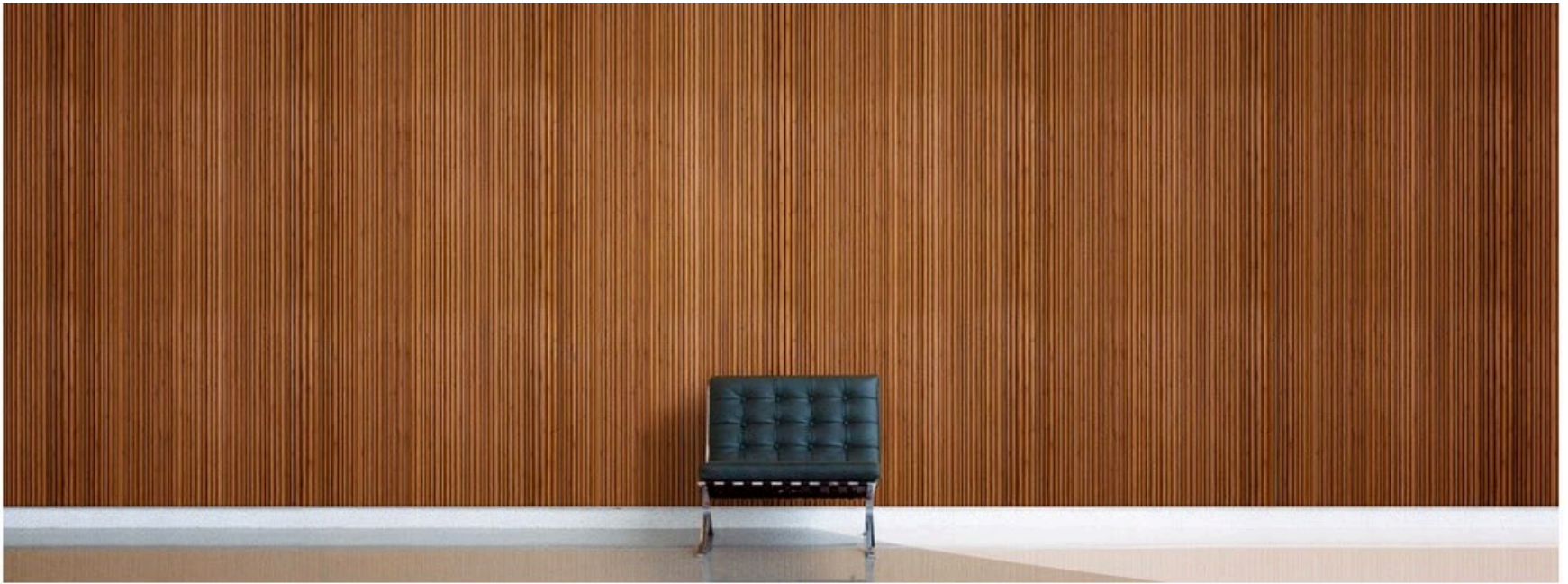


Linear Collection



Reveal Collection





Product Info

Specs

Video

Linear Line Panel Style LL2

Specifications

[CSI 3-part specification - Linear Line Collection](#)

Core Composition: RealCore™ Technology

Color: Amber

Material: 100% Bamboo

Size: 3/4" x 47 3/4" x 95 3/4"

Metric: 19mm x 1213mm x 2432mm

Weight: 90 lbs

Surface Texture: Prefinished or Unfinished

Fire Resistance Classification: Class C (Class B available)

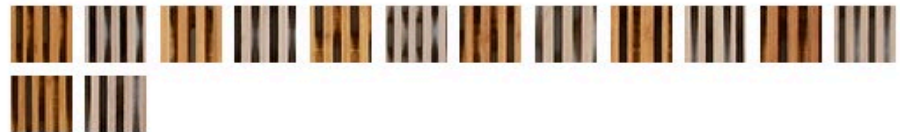
Emission Testing: ASTM-D6007-02: Formaldehyde Concentration in air from Wood Products, small chamber testing

Result: 0.004ppm (surpasses CARB II standards of 0.05ppm and ULEF standards of 0.04ppm)

BP-S4896VA/LL2:

[Installation Guide](#)

Linear Sound Collection



Sound Collection



Linear Collection



Reveal Collection





Product Info

Specs

Video

Linear Sound Panel Design LS14F

Specifications

[CSI 3-part specification - LinearSound Collection](#)

Sound Absorption: QuietWall™ Technology (Test Result)

Core Composition: RealCore™

Color: Fog

Material: 100% Bamboo

Size: 3/4" x 47 3/4" x 95 3/4"

Metric: 19mm x 1213mm x 2432mm

Weight: 80 lbs

Surface Texture: Prefinished or Unfinished

Fire Resistance Classification: Class C (Class B available)

Noise Reduction Coefficient (NRC): avg. 0.70

Sound Transmission Class (STC): avg. 0.00

Emission Testing - CA Section 01350 Protocol: No VOC's with chronic REL's (reference exposure level) detected; passes office, school, and residential criteria

BP-V4896A/LS14F: Carb Phase II Compatible

[Installation Guide](#)

Linear Sound Collection



Sound Collection



Linear Collection



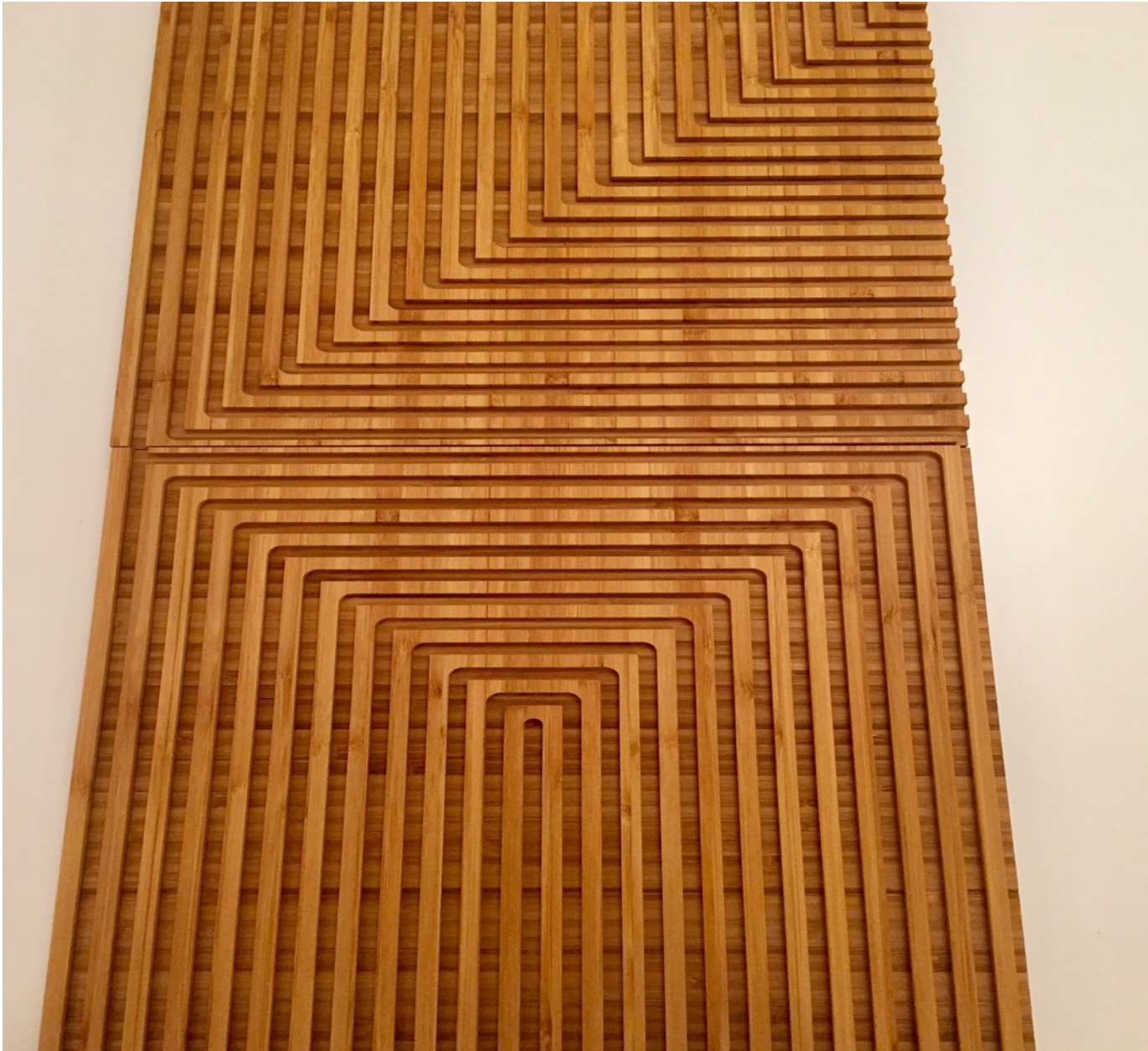
Reveal Collection

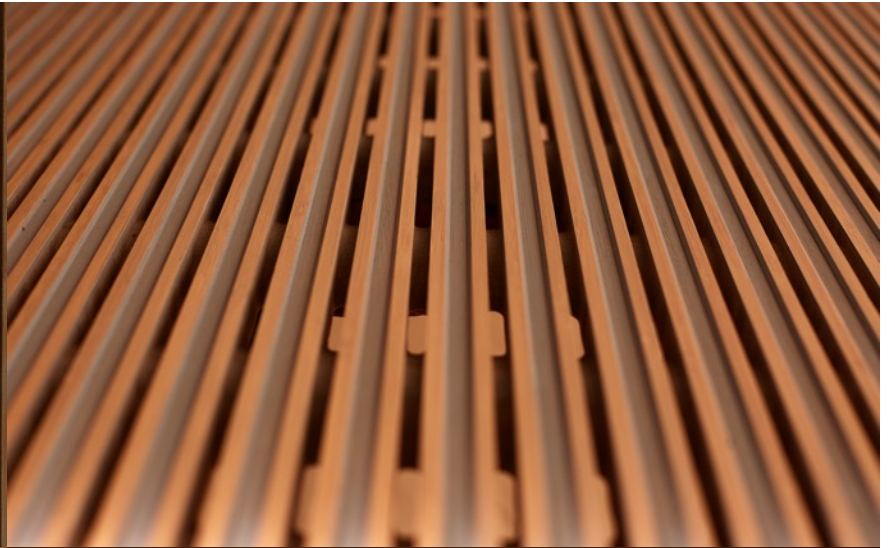


Palm Collection

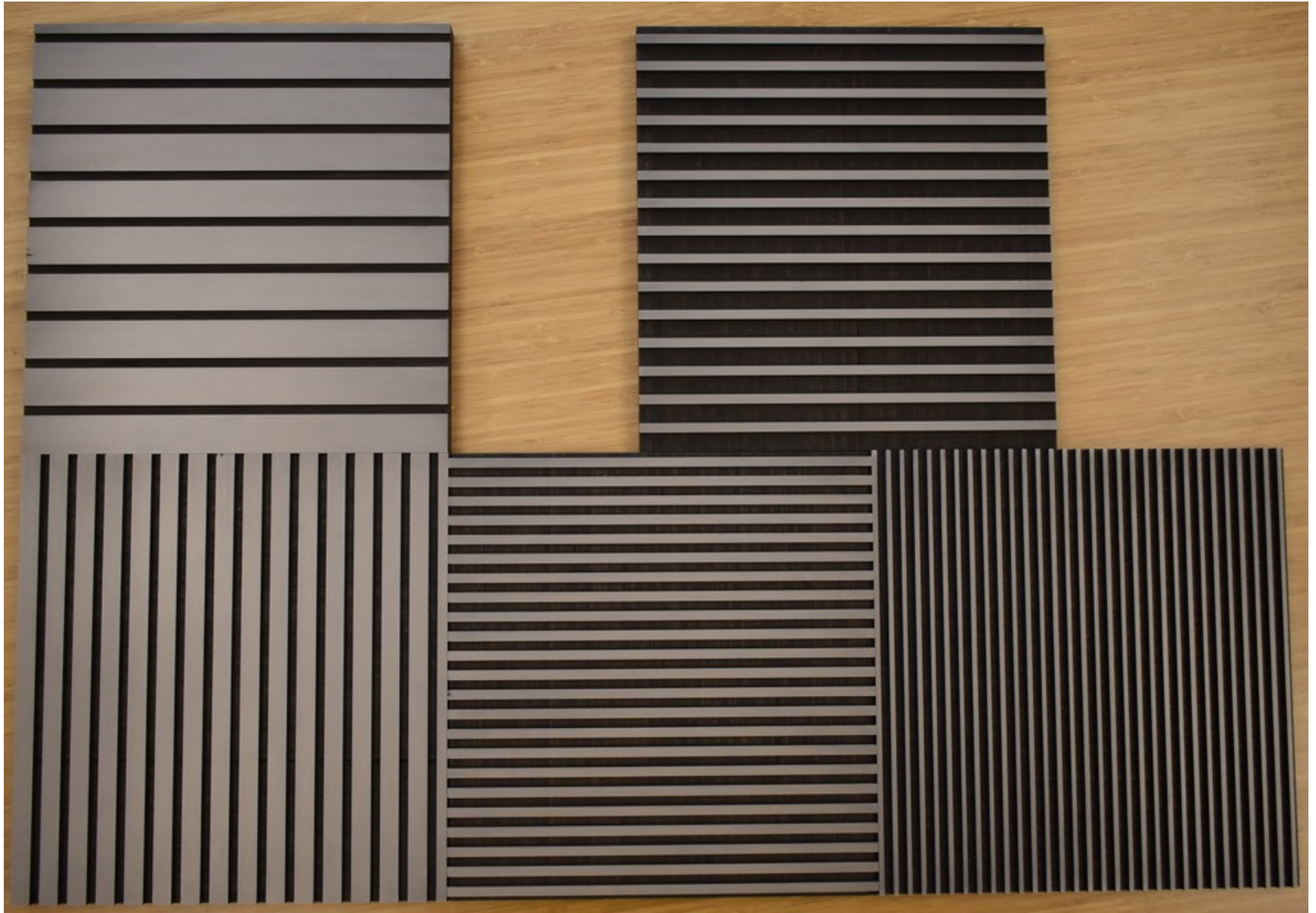














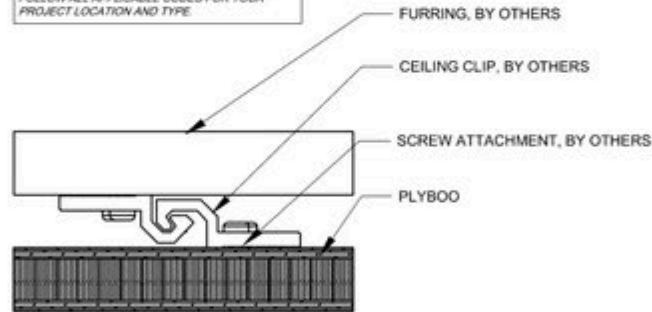
ACCOUSTIC CEILINGS



ACCOUSTIC CEILING

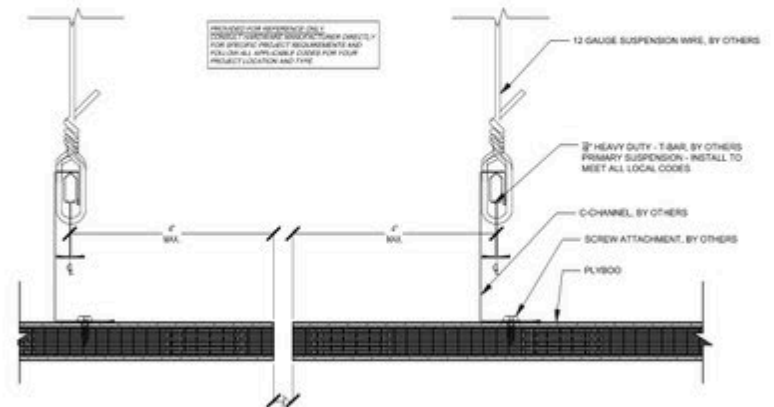


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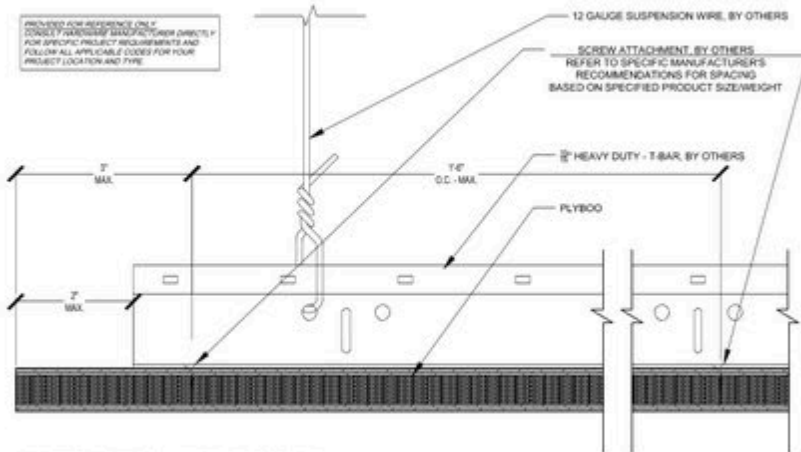
DIRECT MOUNT ATTACHMENT - OPTION 1

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C-HANGER ATTACHMENT

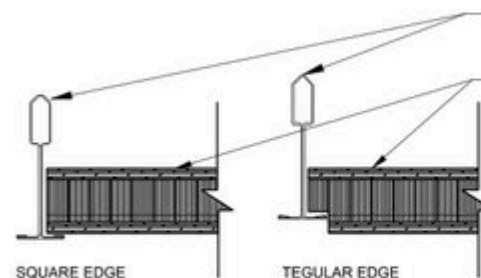
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DIRECT ATTACHMENT TO GRID

2\"/>

PLYBOO - SIZE PER SPECIFIC CEILING MANUFACTURERS REQUIREMENTS



SQUARE EDGE

TEGULAR EDGE

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LAY-IN

ARCHITECTURAL BAMBOO PANELS USED ACOUSTICALLY

- Panels can achieve acoustically absorptive properties by marrying a high performance pad behind a perforated decorative panel.
- Acoustical performance is rated using NRC (Noise Reduction Coefficient) averaging .70
- Absorptive elements may be placed behind (with air space) or attached directly to panels using adhesive
- Edges may be concealed using flange detail or left exposed
- Attachments for panels include z clip and C clips for ceiling and wall applications.

ARCHITECTURAL BAMBOO WITH PERFORATIONS CAN BEND









ARCHITECTURAL BAMBOO PANELS USED IN A MODULAR SYSTEM



BAMBOO PANELS USED IN A MODULAR SYSTEM







23

22

21

26

FORTUNE

COMMUNES FOCUS ON THE FUTURE
FORTUNE
SPOTIFY SAVED THE MUSIC INDUSTRY. NOW WHAT?
Profits and Purpose: Can Big Business Have It Both Ways?
THE 50 MOST POWERFUL WOMEN IN BUSINESS

THE 50 MOST POWERFUL WOMEN IN BUSINESS
FORTUNE
THE TEAM LEADING NETFLIX INTO ITS BIGGEST BATTLE YET
STREAMING WARRIORS

2019 **CHANGE THE WORLD ISSUE**
FORTUNE
Profits and Purpose: Can Big Business Have It Both Ways?
THE 50 MOST POWERFUL WOMEN IN BUSINESS





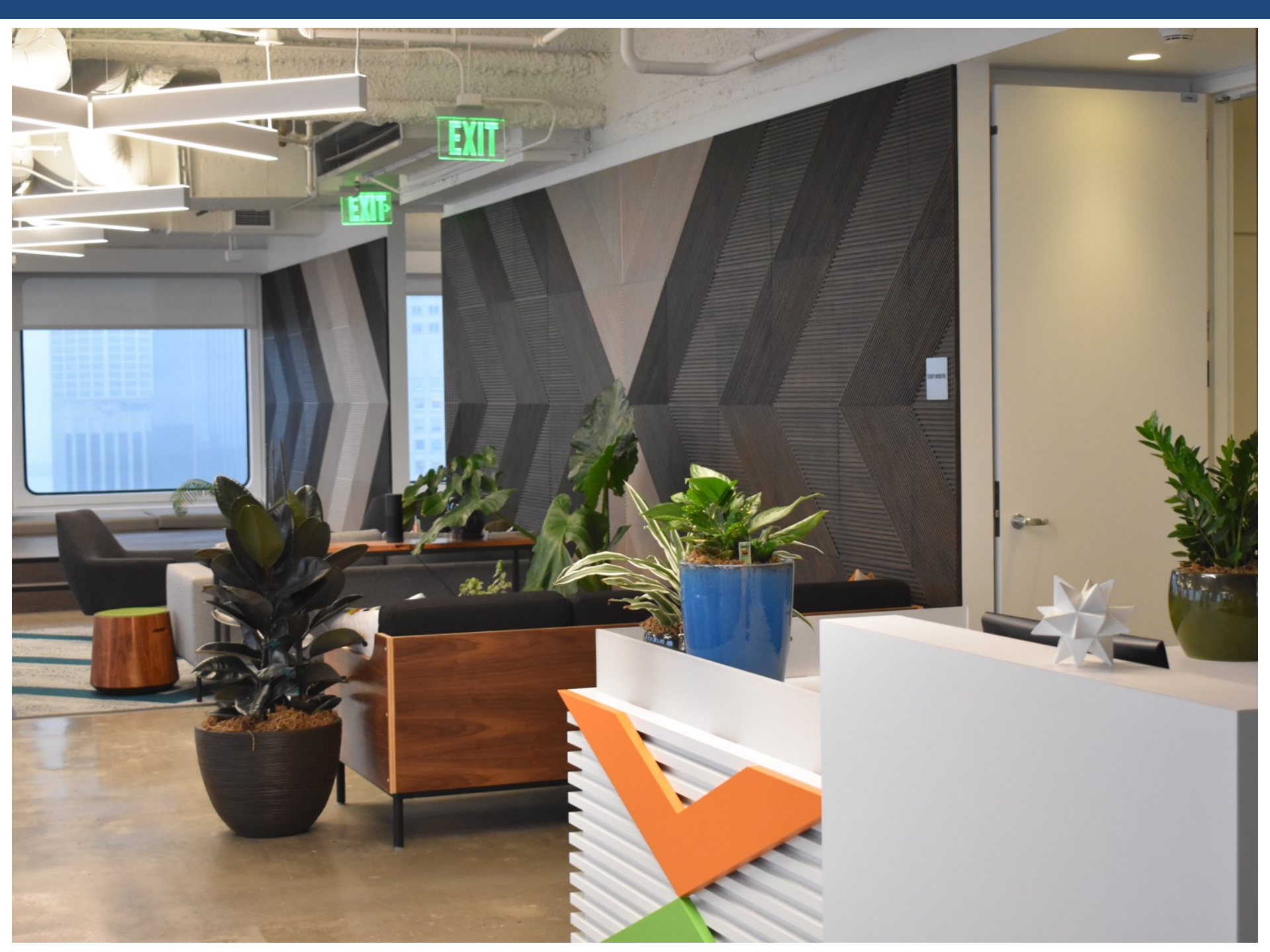


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PLYBOO TIMELINE

- 2019 **Louver™** Panels launch
- 2018 Launch **Futura™** System
- 2017 Life Cycle Analysis and EPD
- 2017 Launch **Fractal™** Wall System
- 2015 **Linear Sound** Panels for Acoustics
- 2014 Decorative Panels **Reveal, Linear and Sound** added to product line
- 2012 **FloorScore** all Flooring Products
- 2010 **NAUF/FSC** Strand Plywood
- 2008 **FSC Certified Bamboo**
- 2007 PlybooPure-CA Section 01350 Passed
- 2006 PlybooSport Sports Court Floor
- 2005 Neopolitan Strand Bamboo
- 2001 Durapalm Plywood and Flooring
- 2000 Strand Bamboo Flooring
- 1996 Bamboo Plywood
- 1993 Bamboo Flooring
- 1989 Pioneered Laminated Bamboo Technique



ARCHITECTURAL BAMBOO PANELS USED IN A MODULAR SYSTEM

<https://design.plyboo.com/>