ICA 2013 Montreal
Montreal, Canada
2 - 7 June 2013

Architectural Acoustics
Session 2aAAb: New Materials for Architectural Acoustics

2aAAb3. From felt to fungus: New materials and applications - Focus on innovation and exploration
Dawn Schuette* and Scott Pfeiffer

*Corresponding author's address: Threshold Acoustics LLC, 53 W Jackson Blvd, Chicago, IL 60604,
dschuette@thresholdacoustics.com

A two-part presentation of new materials for use in architectural acoustics. This presentation emphasizes new materials, both commercially available and those pressed into use for acoustic benefit. The companion session is presented in "Cultivating the Sustainable in Architectural Acoustics." Contemporary architectural design often seeks to push the standard of construction, resulting in the need to explore new acoustic solutions to new architectural challenges. Innovative use of commercially available materials or exploration into the development of new materials or modifications of known materials is required to find the best solutions both acoustically and architecturally. Use of acoustical products and non-acoustical products for acoustical benefit are reviewed through case studies.

Published by the Acoustical Society of America through the American Institute of Physics
INTRODUCTION

Creativity of architectural and acoustical design approaches commonly leads to the best building designs. Often it is this kind of thinking, along with good collaboration, that leads to new acoustical products or innovative uses for commercially available materials.

Buildings are unique, and it is an exception that would result in the same building being constructed twice. It is the specific mix of client, site condition, use requirements, geographic location, and design team that dictate the building program and design. At times, the specific program or design problem requires a new approach to solve the problem in the best way possible for everyone involved. It is in these circumstances that it may be necessary to explore the creation of new materials or products or to look at modification of existing products or use of standard materials in new, perhaps untested, ways to meet the acoustic challenge and satisfy the architectural goals of the project.

Case Studies

Innovation can be found across the building disciplines, and particularly in acoustical design. Acousticians specializing in Architectural Acoustics must work with architectural, structural, and building MEP systems to achieve the project goals with regard to noise control, sound isolation, and interior room acoustics. Budget is always a factor and at times a driver for creative thinking. New architectural approaches or specific building use requirements will also dictate the design approach. Finally, the movement toward more sustainable design or sustainable building operations is evolving the palette of materials available for use within and outside building envelopes. Specific examples are outlined in the case studies that follow.

Architectural Systems Designed to Meet Budget, Acoustic, and Architectural Requirements

The Cobb Energy Performing Arts Centre\(^1\) features the John A Williams Theatre, a multipurpose proscenium theater seating 2750. The program and building site required careful approaches to the acoustic, theatrical and architectural design to meet the needs for touring shows, resident groups, and the project budget. Sufficient volume was necessary within the house to support non-amplified presentations such as opera, while technical capabilities had to accommodate touring Broadway shows and other special theatrical events. The architectural design incorporated a sound-transparent ceiling surface to create a more intimate interior room volume (visually) joined with a larger acoustic volume above. The design developed into a sinuous ceiling form of repeated waves that at times opened up for rigging points or overlapped to hide catwalks and other theatrical elements. The shaping and overlap required a material that would be as acoustically open as possible, while budget restrictions dictated that standard products be evaluated for use in a custom framing design. Acoustic testing looked at angle and openness to determine the best material options, and an open, woven metal mesh was employed.

![FIGURE 1. Ceiling panels at Cobb Energy Performing Arts Centre](image-url)
FIGURE 2. Insertion loss testing at 90 and 30 degree angles for final metal mesh selection at Cobb Energy Performing Arts Centre

A new theater and product demonstration space at the Shure Incorporated3 headquarters incorporates wood slats at side walls open to acoustic absorption. The use of the room is multipurpose, ranging from spoken presentations, product demonstrations, and unamplified music events. The design of the wood slats required uniformity of materials to control costs; however, uniform spacing would have present unwanted acoustic problems and had the potential to make the room too dry for some uses. Testing of prototypes resulted in a design that varied the spacing and angle of the slats to meet the acoustic requirements as well as achieving the architectural vision of creating a warm, wooden room from the audience’s perspective.

FIGURE 3. Wood slat treatment at Shure Incorporated
A new flexible recital, cabaret, special event, and rehearsal space at the Holland Performing Arts Center\(^3\) incorporates wood screens at the lower level of the space to provide a refined architectural backdrop for formal events. The design of the custom wood screen utilizes varying diameter dowels with irregular on-center spacing to create a richly diffusive surface that would also be open to mixed areas of sound-absorption and sound-reflective materials areas behind. Many iterations of design options resulted in the final product, which was a repetitive pattern for cost control, yet rotated 0, 90, 180, or 270 degrees within the frame to provide visual interest and improved acoustic diffusion.

![Image](image_url)

**FIGURE 4.** Wood panels at Holland Performing Arts Center

*Integration of Acoustic Material within Architectural Elements*

The scenography design of the National Museum of Qatar\(^4\) is based on scenic video elements in all galleries to tell the story of the Qatari people. Sound absorption is integrated into ceiling areas throughout the galleries, but multimedia installations required the addition of sound absorptive materials on walls as well in some areas.

Working with the Architect, a solution to incorporate a thin, sound-absorptive fabric within the support structure of display elements, such as large photography screens, seamlessly incorporates sound-absorption without change in the visual character of the space.

*Innovative HVAC Approach*

The new Media Production Center at Columbia College Chicago\(^5\) features two production sound stages among other scenic and teaching facilities for the College. During design it was found that the largest of the Sound Stages could swing dramatically in temperature depending on the use. Small classes might require little cooling; moderate scenic sets would require more; and large staging project with significant lighting would result in staggering cooling load requirements.

Acoustic concerns for such criteria centered on the control of HVAC systems noise. Architecturally and acoustically, the challenge of routing large ductwork through the building to accommodate the highest cooling loads was daunting, and control of noise from airflow proved challenging. The mechanical engineer devised a means of using a mid-height overhead air delivery in conjunction with radiant system for cooling or heating in the floor slab of the space. The combination of these two systems provided an even cooling condition as illustrated in the diagrams below. This solution also reduced the air delivery requirements to a level that would allow large yet manageable sizing of ductwork for supply and return from this space.
FIGURE 5A. Heat flow diagram with radiant floor cooling

FIGURE 5B. Heat flow diagram with conventional overhead supply system

Unique Adaptation of Material and Acoustic and Architectural Approach

The Ford Calumet Environmental Center, which completed design in 2008, would have achieved the highest LEED rating in the United States, utilizing salvaged steel and other elements from the spoiled land of the forest preserve land (former industrial waste site) in which it would sit.

The architectural design is based on highly sustainable practices. In addition to salvage, reduction of waste from the construction site was carefully considered. One of the architectural design solutions is the utilization of the wood slats of the roof slab formwork as a final ceiling finish to limit waste. The open architectural design of the facility required the inclusion of sound-absorptive materials in the building, but limited wall areas necessitated that these treatments be located on the ceiling. Working within the limited thickness of the wood, a design approach was developed with the architect to strategically remove the formwork boards and insert wool felt of the same thickness into the resulting gaps. Felt strips were concentrated in “transition zones” between program areas to allow the wood to be maintained wherever possible and absorption to be concentrated where it would provide the greatest acoustic benefit for either interior room acoustics or sound separation.

The natural wool product additionally met the sustainable goals of the project while providing the necessary sound absorption levels.
FIGURE 6. Diagram of felt within wood slat ceiling system at Ford Calumet Environmental Center

REFERENCES

1. Cobb Energy Performing Arts Centre, Atlanta, GA, USA; Owner: Cobb-Marietta Coliseum & Exhibit Hall Authority; Architect: SRSS Architects; Theater Design: Theatre Projects Consultants; Acoustical Design: Kirkegaard Associates
2. Shure Incorporated, Niles, Illinois, USA; Owner: Shure Inc; Architect: Krueck + Sexton Architects; Theater Design: Schuler Shook; Acoustical Design: Threshold Acoustics LLC
3. Holland Performing Arts Center, Omaha, Nebraska, USA; Owner: Omaha Performing Arts; Architect: Ennead Architects; Theater Design: Fisher Dachs Associates; Acoustical Design: Kirkegaard Associates
5. Media Production Center at Columbia College Chicago, Chicago, Illinois, USA; Owner: Columbia College Chicago; Architect: Studio Gang Architects; HVAC Engineer: dbHMS; Acoustical Design: Threshold Acoustics LLC
6. Ford Calumet Environmental Center, Chicago, IL; Owner: City of Chicago; Architect: Studio Gang Architects; Acoustical Design: Threshold Acoustics LLC