Materials Research

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MATERIALS RESEARCH

Material use and understanding has become more directly linked to architectural practice and to architectural education. Large-scale mock ups, prototypes of portions of assemblies, and design-build academic programs connect design decisions to understanding specific material properties. In the book *Smart Materials and Technologies for the Architecture and Design Professions* Michelle Addington and Daniel Schrodeck acknowledge that unfortunately "the material is chosen long before performance criteria are defined" (pg 27). Today, educated clients and the users of buildings demand to know more about how material selections will impact air quality in buildings, building performance, and overall environmental accountability. Architects must now know more about the materials we specify for use in our buildings and be aware of the full range of impacts of those material decisions.

Architectural educators have an increased responsibility to help our students understand new and often complex methods of evaluating materials. One way schools of architecture are addressing the need for understanding materials is to have a physical materials library. Having a physical library of materials in a school of architecture can allow students to have direct, visual and textural experiences with a material yet the feel and visual qualities of a material are only a small fraction of the information regarding building materials that is useful to designers and students. Material investigations need to include information on where the product or material is manufactured, the physical properties of the material and aspects of how the material will impact the overall sustainability of the building including durability, thermal performance, and indoor air quality. As students become more aware of the complexity of material decisions and increase their material literacy they become better versed in one aspect of overall building sustainability and occupant health.

At the University of Houston we are exploring multiple ways to support our physical materials library and increase material understanding in our college through both required student research and specific research projects. We are engaged with local professionals, including the architectural community, as well as contractors and developers, through several projects of varying duration that provide opportunities for our students and act as a vital link to their increased awareness of the complexity of material decisions.

MATERIALS LIBRARY

Many schools of architecture have a physical materials library. These collections allow students to touch and handle materials directly as well as provide a good overview of the range of materials available. We began our own library by first looking at what other schools and what other architectural firms were doing with materials. By first surveying what was out there we could get an idea on how we might approach building a library for our unique situation and location.

Located within a large dynamic metropolitan area that offers unique cultural, research, and industrial resources, the University of Houston is one the most diverse universities in the country. The Gerald D. Hines College of Architecture takes advantage of this unique setting by offering a comprehensive integration of programs in architecture, industrial design, and space architecture (SICSA). The faculty and students are actively involved in architectural practice, research, and urban issues. The recently completed Burdette Keeland Design Exploration Center is equipped for advanced investigations in computer fabrication, prototyping, and design-build projects.

The College of Architecture has a strong connection to the architectural community. Many of the school's tenured and adjunct faculty are actively engaged in practice. The school is seeking more ways to reach out to the realm of practice and provide students with a clear relationship beyond the confines of the academic institution. With its new program in Industrial Design, the only such program in the state and region, the school is even more focused on the act of making. In order to reinforce the act of making, and strengthen the connection to practitioners, the school has developed a materials library for the use of its students and professional community.

The University of Houston Gerald D. Hines College of Architecture (UH COA) now has a materials collection that is open and available to students as well as to local architects and designers. We see our materials database and research projects as a bridge that connects students with area professionals on matters of innovative materials and sustainable materials.

In addition to a physical materials library, that includes actual physical samples of materials within the college, there is an online database of materials with information about the materials. This information includes physical and mechanical properties of materials, as well as information specific to Houston such as cost, durability, embodied energy, and ability to be recycled. Even though we found that information about the energy used in manufacturing and energy used in transportation is not readily available for many materials, we included those fields for the future. Students, as part of a required building technology course, are actively involved in curating and researching new and innovative materials that get continuously added to the physical sample library and the web based database.

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Figure 1: Image of Materials Research Collaborative's physical material collection

Current architectural practice organizes materials by Construction Specifications Institute (CSI), a format that may hinder true material understanding and explorations. This system is well suited for architectural assemblies but really blurs a better understanding of material qualities. In 1962 the Construction Specifications Institutes (CSI) developed an organizational system for the specifications of building materials and systems used in the construction of buildings. MasterFormat 2004 is a new and expanded version of CSI organizational structure for construction documentation that replaces a older 16 division system with a 50 division system that has expanded categories. While many of the 50 divisions are directly related to material identities most of the categories respond to building construction issues and not directly to the properties of the materials. In fact only four of the fifty divisions are directly related to materiality: Division 03 – Concrete, Division 04 – Masonry, Division 05 – Metals, and Division 06 – Wood, Plastics, and Composites. Division 09 contains both glass and many other interior finish materials. While CSI's MasterFormat remains the "building industry standard" and the primary building material organization system for architects there are many other ways to organize materials.

In the book *Materials: Engineering, Science, Procession and Design*, by Michael Ashby, Hugh Shercliff and David Cebon, material properties are organized by physical properties, mechanical properties, thermal behavior, the electrical, magnetic and optical properties, durability, environmental issues, and finally, the processing and how it affects properties of the materials. The authors also use a family tree of materials that includes metals, ceramics, glass, polymers, elastomers, and hybrids. Each material category shares both a profile of characteristics and also a tree of processes that are common to that material group in the making and manufacturing of objects composed of that material.

Because our college includes both architecture students and industrial design students we organized our materials by material families: metals, polymers,

ceramics, naturals, and hybrids. We do indicate CSI divisions on the label of each physical sample and in the web based database.

INNOVATIVE MATERIALS

The Materials Research Collaborative (MRC) at the University of Houston also seeks to be a leader in bringing innovative materials to the local architectural community. We have partnered with Material ConneXion, an international material consultancy, to bring a library of innovative materials, and access to their database, to our students and our local professional community. This collaboration is supported by several local firms whose annual membership in the MRC helps bring this great resource to our students and to the firms.

As part of a larger outreach effort we have hosted a roundtable discussion in early spring of 2013 with local architects, builders, and large building owners (such as school districts and hospital campuses) to discuss what some of the impediments are to using new materials. We discussed:

How do you select materials to use in a given application?

How does a material become part of your "standard" list?

Can you share an example of a positive experience with a material you were unfamiliar with?

Can you share an example of a negative experience with a material you were unfamiliar with? What did you learn?

How can architects or contractors propose alternative materials?

What information is most important when evaluating new materials?

This began a dialogue we hope to continue with the various participants in Houston who contribute to the built environment.

CONNECTION TO AREA PROFESSIONALS

The Materials Research Collective has other strategies to connect to and support local practice. The MRC has received grants to provide material information to practicing architects in Houston. Most of these grants come from the Architecture Center Houston Foundation (ArCHF).

The ArCHF is a non-profit organization that has awarded over $685,000 in grants through two grant cycles each year and supports local initiatives that promote its mission.

Project ONE: H5h - Local Materials Study

The first project, titled H5h, was funded by a grant by the Architecture Center Houston Foundation. The work began with a survey of local manufacturers from a database purchased from the Greater Houston Partnership. This database had to be edited to find companies that produced materials that might be appropriate in buildings. Local architectural firms were also surveyed regarding any favorite local materials they have used. Each potential company was sent a form in which they were to certify that the materials were manufactured locally and to indicate the location of the extraction of the raw materials. This list was then organized by manufacturer, with each product type indicated, along with manufacturing distance from Houston. This list is made available to all local architects and AIA members and is also available on the UH MRC web site.

Project TWO: Made in Houston

The second project, *Made in Houston*, was funded by two grants, one from the Architecture Center Houston Foundation and a second grant from the Rice Design Alliance Initiatives program. The project began as a way to link local designers to local fabricators and manufacturers. The catalog and web site highlight the local craft and manufacturing available to local designers in an effort to help support local businesses.

The work began with two work study students contacting companies from a database of local manufacturers. A survey form was developed that listed potential materials, equipment, fabrication possibilities, as well as other services such as the ability to provide small or large batches, to provide design help, or have a quick turn around for fabrication. This information was sent back along with photos of finished items and a photo of an item being fabricated in their facility. The information regarding capabilities was then converted into a series of simple icons. Each company has a two page spread in the catalog that includes a brief description, contact information, along with the icons and list of abilities, plus images of items fabricated. A slightly abbreviated format was used to create a website that is searchable by material, company, or keyword. The catalog and web site include large manufacturers as well as small local artisans.

Project THREE: ReUse in Houston

We just received a new grant from the Architecture Center Houston Foundation to catalog places to donate and process building materials. These could be from demolished buildings or from construction waste. Currently 38% of the City of Houston waste stream comes from construction and demolition waste. There are many resources in Houston that are beginning to reuse or recycle construction waste including: Sprint, Waste Management, City of Houston ReUSe Warehouse, Habitat for Humanity ReStore, and Historic Houston. This proposal is to develop a printable and on-line resource for the Houston professional community that includes local businesses and non-profit groups that help reuse or recycle building materials.

Karen Lantz is a local architect who recently responsibly disassembled a house on an inner city site in Houston. She has developed a preliminary list of places architects and building owners can use to recycle building materials. Karen would like to further develop that resource to share with the entire Houston professional community and has decided to partner with the UH MRC. The MRC will be working with Lantz, a University of Houston graduate and intend for this catalog and web site to be useful to help keep building materials out of our landfills and provide useful building materials and components to area organizations and citizens.

In addition to projects that are of use to all area design professionals we also support material understanding with educational seminars, roundtables, and other events. As part of the ongoing communication between the MRC and local architects the MRC offers a CEU titled Materials for Architects. This one hour session is offered both at the College of Architecture and available to be delivered at the offices of larger firms. The seminar provides an introduction to material science and the various issues regarding material selection facing architects designing buildings today.

The MRC has also hosted area architects, contractors, and large building clients at open houses of its physical library, inviting architects and designers to come look at new materials, search for materials on various databases, and discuss other information needed by the local designer community.

Student/Firm Collaborations
Recently a short three week project in a research studio paired groups of three students with a local firm to develop new ways to look at their material investigations. One group looked at a new library project and provided a series of precedent investigations, contextual material studies, as well as a list of materials appropriate for a modern day library.

Another group of students looked at a project to renovate the street level and tunnel level (Houston has a series of connecting tunnels below ground in its downtown core) lobbies of a class B office building. They began by surveying adjacent lobbies and compared interior material cladding of class A vs class B office , tunnel vs street level, and across time.

PROJECT SPECIFIC RESEARCH

In order to fund these gerneral activities we also seek opportunities for particular and focused research projects. These provide an opportunity for our students who need to work to have employment at the university and work on projects that increases their professional skill set.

Research Project One: SUSTAINABLE MATERIALS
In fall of 2011 we began an analysis of eight different material applications across multiple sustainable criteria for a new day care building.

We looked at four or five different specific materials for potential use in the building in each of these categories: tackable surfaces, acoustical/structural roof deck, interior base, millwork substrates, countertop materials, exterior woodcladding, glass storefront, and window coverings.

We then researched and provided information on the multiple aspects of each material such as: compostable/biodegradable, percentage post-consumer waste, percentage pre--consumer waste, recyclability in Houston municipal recycling centers, location of raw materials extraction, manufacturing location , transportation method, VOC content, Forest Stewardship Council certification, Cradle to Cradle certification, LEED 2009 possible points, Green Guard Children & Schools certification, Pharos Project Score for VOC, Pharos Project Score for UseTox, Pharos Project Score for MfrTox, Pharos Project Score for RnMTRL, Pharos Project Score for RnENERG, Life Cycle Analysis, Embodied Energy, carbon emissions, Material Safety Data Sheet, Living Building Challenge Red List, performance/quality/warranty information, local installations, and cost.

This information allowed the architects and building owner to select the materials that best aligned with project's specific sustainability priorities. Because this project was a daycare facility the indoor air quality of the facility and the health of the young more fragile building occupants was prioritized.

Research Project Two: CARBON @ 3009 POB
In the fall of 2012 we began working on a carbon analysis for an office building under construction and tracking the carbon emissions used in the construction of the building including: manufacturing and transportation of

building materials, waste, on site energy, and transportation of workers. This analysis will allow the developer client to be more strategic with design decisions regarding carbon emissions implications for future projects.

Research Project Three: LEED v4 consulting

We are just beginning to work with a local developer to assist with the identification of potential materials for a new office tower downtown that is being designed to meet LEED Silver, version four. LEED version four has three new potential cedits relating to Environmental Production Declarations (EPDs) and overall transparency of information regarding material manufacturing, chemical content, and raw material extraction. We are assisting to identify potential products that may be used in the project and the overall potential for using LEED version four.

Through all of these projects, programs, and events we hope to connect students with area professionals who are also learning more about materials. Part of our mission is to get students excited to know more about building materials, including their visual and tactile qualities. We also know that we have a responsibility to increase our technical understanding of materials and the implications of material choices on this fragile environment.

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