“By understanding materials’ basic properties, pushing their limits for greater performance, and at the same time being aware of their aesthetic values and psychological effects, an essential design role can be regained and expanded.”

1. Samples in the Cal Poly Materials Library show the various compositions of wood products.

Simply put, the two issues weighing most heavily on the future of the built environment are sustainability and integrated practice. The bulk of this paper could be devoted to the discussion of this terminology and nuances of these labels, but for my purposes they are adequate in capturing the issues pressing on the discipline of architecture, namely a careful reconsideration of the resources and processes used to create buildings. It follows then, that the education of architects, engineers, construction managers and all others involved in the creation of the built environment will have to change to make these two issues central to their curricula. Acknowledging the lengthy process of thoughtful curricular reform, this presentation looks at an effort by faculty and students at California Polytechnic State University to use materials as a platform to introduce small, but immediate measures to address these issues. Specifically, we created a new materials library intended to

1. promote an increased awareness of materials, especially in relation to sustainability, and
2. provide a setting for collaboration between students of architecture and related disciplines where a spirit of integrated practice can develop.

The first part of this paper examines the rationale behind using materials as a springboard to larger scale curricular reform; the second part discusses the creation of the Materials Library at Cal Poly.

Materials and the Senses

Our decision to use materials as the change agent was inspired by a number of sources, among them the argument for an architecture of the senses articulated by Juhani Pallasmaa. In his various related essays such as “Eyes of the Skin”, “Six Themes for the Next Millennium”, and “Hapticity and Time”, Pallasmaa argues that the task of architecture is to create embodied and lived existential metaphors that concretize and structure our being in the world. To accomplish this, architects must resist the ocular-centric tendencies of contemporary culture and pursue what Pallasmaa refers to as “haptic architecture,” an architecture created for all five senses.

“Our culture of control and speed has favored an architecture of the eye, with its instantaneous imagery and distant impact,” Pallas-
maa writes, “As buildings lose their plasticity and their connection with the language and wisdom of the body, they become isolated in the cool and distant realm of vision. With the loss of tactility, measures and details crafted for the human body—and particularly for the hand—become repulsively flat, sharp-edged, immaterial and unreal. The detachment of construction from the realities of matter and craft further turns architecture into stage sets for the eye, and into a scenography devoid of the authenticity of matter and construction.”

“Every significant experience of architecture is multi-sensory; qualities of matter, space and scale are measure by the eye, ear, nose, skin, tongue, skeleton and muscle.” Pallasmaa continues: “Haptic architecture promotes slowness and intimacy, appreciated and comprehended gradually as images of the body and the skin. The architecture of the eye detaches and controls, whereas haptic architecture engages and unites.”

**Materials and the Environment**

While it is imperative that designers be aware of the tactile qualities of materials, they must also be cognizant of their social and environmental impacts. This is no easy task, since it is estimated that a greater number of new materials and products have been developed in the last twenty years than in the entire prior history of materials science.

In *Material Architecture*, John Fernandez underscores the heightened relationship between materials and the environment. He writes, “Today, improving the environment requires a reconsideration of the contribution of materials in the process. One such issue is the relationship between the production and consumption of materials and the service lifetime of buildings. Yet, buildings constitute an enormous store of materials used in construction—primarily due to their long lives. Understanding and designing within an organized ecology of the built environment, and not just for a single project’s needs, requires more information about the material flows for construction.”

Not only is the scope of this task, that is understanding materials in holistic terms, extremely daunting, its also a task that is constantly changing as materials both enter the market or become obsolete. Its clear to us that the focus can’t be on specific materials, but rather be on a methodology that can be used by students throughout their careers to research and evaluated materials.

**Materials as a Form of Research**

We are also inspired by architects and engineers who view research into new materials as an opportunity rather than a burden; these designers are not only comfortable with advances in technology and materials, but also see this research as an integral component of the design process.

Jacques Herzog and Pierre de Meuron focus much of their creative energy on the use of innovative materials. Herzog has written, “We look for materials that are as intelligent, as virtuoso, as complex as natural phenomena, materials that not only tickle the retina of the astonished art critic, but that are really efficient and appeal to all of our senses” (see Figure 2).

On this last point, Herzog echoes Pallasmaa’s argument for a haptic architecture. Herzog continues: “Our work has always been conceived to appeal to all five senses, consciously involving also tactile issues and even smell. This clearly demonstrates that we believe in an architecture that stresses its material and physical conditions to perform successfully, in conscious contrast to an architecture based on illustration and imagery.”

The interest in materiality by these architects and others, is in part propelled by two
trends: the appropriation of materials developed for other fields by architecture, and a growing concern for resource management and material ecology. To engage these trends, designers must work with a steady hand and a willingness to research the intersection of new materials and their effective, sustainable incorporation into built works.

Herzog writes: “This is a strategy that gives us the freedom to reinvent architecture with each new project rather than consolidating our style. It also means we are constantly intensifying our research into materials and surfaces sometimes alone and sometimes in collaboration with various manufacturers, laboratories, with artists and even with biologists”.

Herzog’s words underscore two important considerations in the discussion of materiality. The first is that innovation can no longer take precedent over environmental responsibility. The second is that unless architects are willing to devote all of their time to the research and development of materials, they’ll have to engage other disciplines. This active collaboration, of course, is also at the heart of integrated practice.

The redefinition of the process used to create architecture, as well as the shifts in the relationships between disciplines involved, is the focus of Refabricating Architecture by Stephen Kieran and James Timberlake. In it they observe the integrated modes of production used to create complex objects such as automobiles and airplanes and assert that architecture should be designed and produced in a similar way (see Figure 3). They write, “The process of making is no longer entirely linear. Producers engage in design, and designers engage in production. Production becomes part of the design process by working with assemblers from the outset, designers picture how things are made, their sequence of assembly, and their joining systems. Materials scientists are drawn into direct conversation and problem solving with engineers and even with designers. The intelligence of all relevant disciplines is used as a collective source of inspiration and constraint”.

Take for example Thom Mayne of Morphosis who graduated from architecture school in 1969. For the first thirty years of his career he practiced as he was taught: using a traditional process with clear distinctions between creative and technical efforts. Ten years ago he computerized his office and ever since has followed new visualization, communication and fabrication technologies as they first emerged, then converged. His incorporation of these technologies into the working culture of his office transformed their approach to architecture.

About the process used for the Federal Building in San Francisco Mayne observes, “We did no two-dimensional drawings for this project. Three-dimensional models provided continuity from the initial concept to construction documents. The design model connects directly with the Permasteelisa Group, which continued through the design process, blurring the line between the architect and the sub-contractor. The model feeds directly into prototyping; and finally, into the fabrication and assembly of the construction. This environment is no longer linear. It allows us to continually move back and forth between micro and macro.”
To hear Mayne tell it, the future is here and it is both demanding and liberating. He writes, “The tools we now utilize simplify potentials and make them logical, allowing us to produce spaces that even ten year ago would have been difficult to conceive, much less build. Our conceptual thinking is increasingly embedding tectonic, constructional, and material design parameters.”

The Responsibility of Educators

The question is not whether architectural education has a responsibility to respond to these changes in the profession. The vexing question is how. A compelling argument can be made that a complete and radical rethinking of architectural education is necessary. Daniel Friedman makes such an argument when he asks, “What would happen if each architecture school dismantled not just its current curriculum, but also its entire instructional apparatus? What would happen if schools acknowledged design as an epistemology more so that a skill; reoriented the development of individual expertise to the ethos of the team; and elevated building technology, engineering, construction economics, and professional practice to the same cultural status as visual composition?”

Recognizing both the validity of Friedman’s questions and the overwhelming scope of a complete reformulation of architectural education, the Department of Architecture at Cal Poly looked at its program and formulated some more modest questions designed to frame immediate changes to how architecture is taught. How can we create an environment that encourages the ethics of sustainability and inculcates a spirit of collaboration between disciplines? What other types of active learning spaces, besides the studio environment, can inspire the engagement of materials to a higher degree and generate research into materiality?

The Materials Library at Cal Poly

The Architecture Department at Cal Poly has the fortunate circumstance of being in a college that includes most of the disciplines mentioned by Thom Mayne and Jacques Herzog. Along with architecture, the College includes architectural engineering, construction management, landscape architecture and city planning. Although the inclusion of all the design and construction disciplines in one college is beginning to translate into interdisciplinary efforts, departments still suffer from insularity.

As with most schools, departments at Cal Poly have separate classes for students, even for those subjects held in common such as materials. On one hand, this is expected and desirable for it allows classes to be highly specialized for their respective disciplines: courses for architects tend to emphasize qualitative over quantitative aspects of materials, while courses for engineers tend to emphasize the quantitative over the qualitative. While the specialization of these courses is somewhat justified, the result is that students develop different languages to discuss the same topics, a potential impediment to future collaboration.

In Materials for Design, Mike Ashby and Kara Johnson observe that, “Bridging the gap in information and methods is not simple. The technical terms used by engineers are not the normal language of designers –indeed they may find them meaningless. Designers, on the other hand, express their ideas and describe materials in ways that to the engineer sometimes seem bewilderingly vague and qualitative. The first step in bridging the gap is to explore how each group ‘uses’ materials and the nature of the information about materials that each requires. The second is to explore methods, and, ultimately design tools that weave the two strands of thinking into an integrated fabric”.

The Library’s Physical Component

In 2007, we initiated a Materials Library that we believe has the potential to become a setting for information gathering and innovation, the measures suggested by Ashby and Johnson as necessary to bridge the gap between designers and engineers.

The Lab is loosely modeled on the Materials ConneXion, a materials service created by George Beylerian, which is self-billed as the largest global resource of new materials. Although Materials ConneXion is a privately owned and profitable business, its model of providing both physical space (for samples and exhibits), as well as a complete internet-based database provided us with a viable construct to use as a point of departure.

When setting out to create the Materials Library, we made the physical collection of materials our highest priority so as to encourage our students’ appreciation and awareness of
materiality. We located the collection within our Media Resource Center, a collection of books and reference materials shared by all disciplines in the college. Assuming a space of roughly 1000 sf, the physical collections area is complemented by a meeting area and an exhibition area (see Figure 4).

The collections area is a work in progress. Currently we hold about 400 samples with plans to expand these holdings to 2000. Since it is impossible to have a physical sample of every material, the emphasis of the collection is on new materials, green materials and smart materials. We encourage students to browse the collection, touch and smell the samples, feel their weight and tactility; i.e. consider the haptic possibilities that open up when a designer or engineer engages a material for the first time. A browsing collection offers serendipity: students may begin by looking for a specific material but often leave with several other materials in hand for future projects.

Although we are constantly revisiting our decision, the collection was organized by classifying materials according to the CSI Masterformat, the general specifications format most commonly used by all A/E/C disciplines in the US (See Figure 5). Eventually we may move away from a system that classifies materials by application and towards a system that classifies materials by properties. This will encourage students to think beyond narrow applications and consider materials for their form, aesthetic and technical performance, and fabrication method.

The meeting area is an active learning space for groups and individuals to meet and examine materials. This is the “think tank” component of the space, and it is designed to be flexible enough for individual research, class meetings and presentations by manufacturers.

Also included in Library is an exhibition area. Here, exhibits of all types can be created: materials can be pulled from the collection and given special prominence, juxtapositions can be created across materials classifications, and new materials or products can be highlighted. This area, like the active learning area, was designed to be flexible in anticipation of exhibits we’ve yet to imagine.

The Library’s Digital Component

Materials are physical and cultural artifacts that are loaded with information of many types, some understandable through empirical means and others only through intellectual engagement. Where is its place of origin? What is the history of its use? What are its performance characteristics? What are the economics of its production? What are the life cycle implications of its use?

A component of the Library that’s integrally related to the physical component is a searchable database (see Figure 6). Data entries will be created for each material sample, in the collection and this information (manufacturer and contact info, process, possible uses, environmental implications, etc.) will be linked back to the physical sample with a barcode. Digital cataloguing will serve the obvious purpose of facilitating the checkout and inventory of samples. More importantly, it will interface with two important stages of student design projects: ideation and development. At the early stage of a project students can use the database to browse broad ranges of materials; as with the physical collection, serendipity factors into the browsing activity as cross-links allow students encounter unexpected materials. At later stages of de-
sign projects, students will use the database to access performance characteristics of the materials they’ve selected.

In both of these scenarios, the database is meant to interface with the physical collection as students move back and forth between the two different, but related learning experiences. The database allows materials in the collection to be searched and studied from any computer, thus supplementing the hands-on experience of physical samples with information that allows the student to understand the place of a particular material in the large context of an increasingly complex material culture. In the future when Building Information Models are more widely used by students, the database will provide an important linkable resource.

Conclusion

Although the necessity to reformulate architectural education in response to the ecological and technological changes that are transforming practice is pressing, thoughtful curricular reform will likely take years. While larger curricular discussions occur at Cal Poly, we saw an opportunity to create a learning space for use by all disciplines in the college, that would not only encourage increased awareness of new materials, but also promote interdisciplinary exchange between students of architecture, engineering, construction management and landscape architecture. Although currently in its infancy, the Materials Library, with its physical and digital components, is positioned to promote a culture of materiality and interdisciplinarity, and in doing so encourage an increased awareness of sustainability and integrated practice.

Notes

1 “Material Matters” is borrowed from a number of sources. It is the title of a book by Grozer and Commoner which argues for a sustainable materials policy (MIT Press, 2001), the title of a trade show of cutting-edge materials organized by the Materials ConneXion, and the name of a non-profit organization that provides low-cost building materials to other non-profits involved in community revitalization or affordable housing projects.
4 Ibid.
8 Herzog from his Pritzker acceptance address, 24.
11 Ibid.
14 The idea behind Material ConneXion and a catalog of some of their collection may be found in the book Material ConneXion by George Beylerian, Andrew Dent and Anita Moryadas, (New York: John Wiley and Sons, 2005).