

Perbellini Course Notes

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Office hours: MW 12.00-1.30 or by appointment.

Assignments, readings, web-sites, digital-info

A list of assignments, links, books, articles, references, web-materials, images, lectures, comments and communications will be posted on the studio blog.

Studio Blog

<http://5301perbellini.blogspot.com>

<http://5334perbellini.blogspot.com>

See Course Syllabus for descriptions, goals, methods, and requirements.

Smart Materials and Building Envelopes

The course will study emerging materials and technologies from building components. Students will engage in analysis, research and development of design, and manufacturing of innovative and high performance assemblies. With the focus on explorations of materials properties and behaviors, we will try to understand the potentials for innovation through a “smart application” in contemporary design practice.

Smart materials have changeable and thus responsive properties, they perform responding to multiple stimuli. Our investigation will speculate on the ability of specific elements that may form an intelligent sustainable system by optimizing their inherent characteristics.

Recent research driven products of the industry based on photochromic, thermochromic, electrochromic inputs or anti-pollution pavement, shape memory alloys, and many others examples will be further explored in their application potential.

The course will be involved in the question of how materials may have different rarely applied properties and how this changes and amplifies the range for new implementations in building design.

Students will be given a hands-on experience from small scale models to large scale mockups in different methods of fabrication, exploring material resistances and employing the equipment of the digital design and fabrication laboratory.

Phase 01: Definition and Classification

Reference - Reading Tip:

Michelle Addington, Daniel Schodek: *Smart Materials and Technologies*, Architectural Press, 2005

In this book materials and technologies are categorized by **behavior- physical and phenomenological-** and overlaid with increasing component and system complexity.

Smart Materials characteristics:

SM – Type 1: Property changing-Intrinsic response variation of material to specific internal or external stimuli (Thermochromic, Magnetorheological, Thermotropic, Shape memory):

SM – Type 2: Energy exchanging- responses can be computationally controlled or enhanced (Photovoltaic, Thermoelectric, Piezoelectric, Photoluminescent, Electrostrictive)

A smart material has an inherent “active” behavior that makes it to fit into several categories. For example: electrochromic glass is simultaneously a glazing material, a window, a curtain wall system, a lighting control system or an automated shading system. It has a lot to do with new technologies.

It is necessary a multi-layered classification of SM according to its physical behavior (what it does) and the phenomenological behavior (the results, the effects, the actions, what do we want the material to do?, the architect’s intention). The SM produce direct effects on the energy environments (luminous, thermal, and acoustic), or indirect effects on systems (energy generation, mechanical equipment).

Phase 01: Definition and Classification

Assignment 1.1

Traditional Architectural Classifications:

USA- Construction Specifications institute (CSI)
Material ConneXion
Technotextiles (book on Fashion Design materials)
Other Classification Systems (Material Science, Engineering)

The internal structure of materials:

Related to material behavior. Knowledge of atomic and molecular structure to understand the intrinsic properties of materials. Bonding forces.

- Solid materials

Properties of materials:

- **Intrinsic properties** (molecular structure- chemical composition- for ex. strenght)
- **Extrinsic properties** (macrostructure-for ex. optical properties)

Total of 5 material properties indicative of the energy stimuli that every material must respond to:
mechanical, thermal, electrical, chemical, optical.

Traditional Materials characteristics:

TM- Fixed responses to external stimuli (material properties remain constant under normal conditions).

TM may range from:

- 1) Primary material classes:
 - Metals (pure metals, transitional metal);
 - Ceramics;
 - Polymers .
- 2) Derivated classes:
 - Composites (High performance strength or stiffness applications. Reinforcing materials, Resin and Matrix materials, Core materials)

Nanomaterials (Nanotechnology)