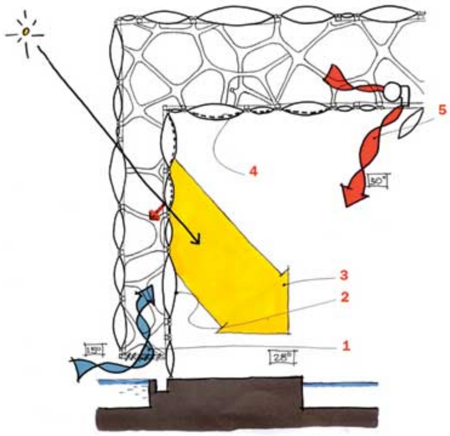
Course Number

AS3031 Environmental Systems II

SCI-Arc Semester

Fall 2012



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Instructors

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Course Meetings

Tuesdays, 7PM to 10PM
Room 226

Course Description

"…architectural history as it has been written up till the present time has seen no reason to apologize or explain away a division that makes no sense in terms of the way buildings are used and paid for by the human race, a division into structure, which is held to be valuable and discussable, and mechanical servicing, which has been almost entirely excluded from historical discussion to date."[2]

"…free-flowing interior spaces and open plans, as well as the visual interpenetration of indoor and outer space by way of vast areas of glass, all pre-suppose considerable expense of thermal power and/or air control, at the very least."[3]

Environmental systems for buildings, both active and passive, remain a rather unloved research pursuit within architecture, even some 40 years after the architectural historian and critic Reyner Banham lamented the fact in his book, *The Architecture of the Well-tempered Environment*. At times called building science, building physics, architectural engineering,

[1] Passive heating diagram from the Beijing National Aquatics Center, courtesy Arup.
[2] Reyner Banham, *The Architecture of the Well-Tempered Environment*, (London: The University Press, second impression, 1973), page 11.
[3] Banham, page 86.

environmental services, or, lately, traveling under the guise of "sustainability," the consideration of light, air, and sound, and their corollaries of water, energy, and materials, are critical to the creation of architecture that is both sensitive to the contemporary challenges of resource scarcity and climate change, as well as successful in providing humane and comfortable environments for people.

This course will focus on understanding and applying the key technical principles of fundamental physics and environmental design for air, light, and sound, using core texts and material from architectural discourse, building science research, and case studies of significant buildings. The class will provide a clear understanding of terminology and how technology is positioned within the profession. Using this foundational research, students will develop an approach to building systems and analysis that responds to ecological and environmental demands and understand how to conceptually deploy them in a design project.

Course Organization

The course will begin with an overview of basic physics and then proceed toward an exploration of the constraints of climate and how the human body responds to climate. Each successive lecture will then build on these constraints to study how architecture has developed in response, with lectures devoted to passive design, introductory mechanical systems, lighting and daylighting architectural materials , building controls and networks, and acoustics. These topics will be combined into a consideration of integrated design of buildings and cities, with the final component of the class focused more on ecological issues such as biomimicry, climate change, and sustainable design. Case studies of projects will be used to illuminate each week's lessons. Class will consist of a three-hour lecture, divided by lecture topics, responding in part to the assigned reading.

Course Objectives

- Situate the concept of "comfort" and its support structures within historical and contemporary architectural practice, understanding how environmental systems have been deployed in both successful and failing examples of design.
- Understand the principles of environmental systems' design, such as embodied energy, active and passive heating and cooling, indoor air quality, solar orientation, daylighting and electric illumination, and acoustics; including the use of appropriate performance assessment tools.
- Understand the relationship between human behavior, the natural environment, and the design of the built environment.
- Gain the ability to design projects that optimize, conserve, or reuse natural and built resources, provide healthful environments for occupants/users, and reduce the environmental impacts of building construction and operations on future generations through means such as carbon-neutral/net-zero energy design, bioclimatic design, and energy efficiency.
- Analyze site characteristics such as soil, topography, vegetation, and watershed in the development of a project design.
- Understand the basic principles and appropriate application and performance of buildings service systems such as plumbing, electrical, vertical transportation, security, and fire protection services.

- Understand the basic principles used in the appropriate selection of construction materials, products, components, and assemblies, based on their inherent characteristics and performance, including their environmental impact and reuse.

Course Grading

- Participation and presentations: 15%
- Project #1: 10%
- Project #2: 10%
- Project #3: 10%
- Final project presentation: 15%
- Mid-term exam: 20%
- Final exam: 20%

Readings

One or more assigned readings will be given for each week's lesson. The readings will be available for download as individual PDFs on the class's online mysciarc page, while some hard copies from books will be available on reserve in the Kappe Library. Readings will be selected from the list provided in this syllabus and will be announced in class. Students will be expected to undertake the readings, as this material will be covered in class and covered on the exams.

Projects

Working in pairs, students will be assigned three projects throughout the semester that will focus on the core class subjects of air, sound, and light. These projects will consist of an analysis of a space within the main SCI-Arc building that will inform a written and visual demonstration of the core subjects. Students will then be asked to present their projects to the class. The projects will be graded based on the following criteria: demonstration of understanding of class concepts, visual quality, accuracy of environmental descriptions/illustrations, presentation quality, and critical insight. Students will be given feedback and partial grades for projects throughout the semester. At the end of the semester, students will combine the three projects into a single display board (24"X36"), incorporating review comments and further analysis into an overall final presentation. Final boards will be exhibited as part of the semester review and are also to be submitted electronically.

The projects consist of the following:
Project #0: Downtown LA analysis - Individual
Project #1: Air
Project #2: Sound
Project #3: Light

Participation

It is expected that students will attend each class in its entirety or notify the instructor at least 24 hours prior to class for appropriately excused absences, as per school policy. Occasional pop quizzes will be given in class to gauge the completion of readings and participation in class lectures and discussions. These quizzes will count toward the grade for participation and will be given at the discretion of the instructors.

Exams

An exam will be given during class at two times during the course of the semester. Exams will require approximately one hour of class time. Exams can consist of both short answer, true/false, and multiple choice questions focused on the technical content of the course topics, as well as diagrammatic sketches and problems the student must analyze and annotate for environmental systems.

Course Schedule

Week 1/September 4: Introduction to course content; Energy and Basic Physics; Comfort in architecture; Definitions for climates, microclimates, and building use and expectations; overview of readings; **Project #0**;

Week 2/September 11: Building physics; Thermodynamics and heat transfer; material properties and thermodynamic behavior; water; units of measurement; basic fluid dynamics; **Presentation of Project #0;**

Week 3/September 18: Ecological imperatives and the emergence of "sustainability"; Drivers of change for ecological design; Aspects of the environmental movement and architecture; Sustainability versus green buildings; Measuring, verification, and transparency in sustainability; Setting key performance indicators for environmental sustainability; Designing for climate change; Sustainable materials selection criteria and constraints; Lifecycle assessment;

Week 4/September 25: Human comfort; The body and heat; Human behavior and expectations; Active and passive; definitions and measurements of comfort; building comfort research; **Project #1**: introduction;

Week 5/October 2: Site design, passive design, indoor air quality; Site design and building orientation considerations; Defining passive design, understanding its historical context; **Project #1**: review;

Week6/October9: Air and water systems; A short history of mechanically tempered environments in architecture; Overview of mechanical systems; Tools for optimizing energy and thermal comfort; Case studies of passive and active mechanical systems; Sketching and representational techniques; **Project #1**: presentation;

Week 7 /October16: Acoustics Part 1; Introduction to architectural acoustics; acoustical comfort; **Mid-term exam; Project #2** introduction;

Week 8/October 23: Acoustics Part 2; Visit to Arup's Sound Lab; **Project #2** review;

Week 9/October 30: Lighting 1; Daylighting fundamentals, health, and visual perception; Design tools for daylighting and shading systems; The use of glass in architecture, techniques for analysis; Defining envelopes and understanding heat gain; Sketching and representational techniques; **Project #2** presentation; **Project #3** introduction;

Week 10/November 6: Lighting 2; Electrical lighting and electricity; Introduction to electric lighting concepts; Overview of lighting technology and design techniques; Planning for building electrical systems; Zero energy buildings and/or planning for a carbon-neutral future; **Project #3** review;

Week 11/November 13: Systems of Measurement and Control; Low-voltage systems, including security, AV/IT, fire alarm and fire suppression, communications technology; Vertical transportation; Building controls and feedback; Urban informatics; **Project #3** presentation;

Week 12/November 20: Final Exam;

Week 13/November 27: Integrated design: Optimization of air, sound, and lighting systems for buildings;

Week 14/December 4: Final project presentations (boards due);

Class Readings List

1. Daniels, Klaus. *Advanced Building Systems: A Technical Guide for Architects and Engineers*. Basel, Switzerland: Birkhauser, 2003.
2. Smith, David Lee. *Environmental Issues for Architecture*. New York: Wiley, 2011.
3. Banham, Reyner. *The Architecture of the Well-Tempered Environment.* London: The Architectural Press, 1969.
4. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) standards, including ASHRAE 55, 90.1, and 189.
5. Addis, Bill. *Building: 3,000 Years of Design, Engineering, and Construction*. London: Phaidon Press Limited, 2007.
6. Gould, Kira and Lance Hosey. “What are comfort and delight?” in *Women in Green: Voices of Sustainable Design*. Bainbridge Island, Washington: Ecotone, 2007.
7. Moe, Kiel. *Thermally Active Surfaces in Architecture*. New York: Princeton Architectural Press, 2010.
8. Halliday, David, and Robert Resnick and Jearl Walker. *Fundamentals of Physics, Fourth Edition*. New York: John Wiley & Sons, Inc., 1993.
9. Heschong, Lisa. *Thermal Delight in Architecture*, MIT Press, 1979.
10. Brager, Gail S. and Richard de Dear. “Climate, Comfort, and Natural Ventilation: A New Adaptive Comfort Standard for ASHRAE Standard 55,” in *Proceedings: Moving Thermal Comfort Standards into the 21st Century*. Oxford Brookes University, Windsor, UK, April 2001.
11. Williams, Daniel E. *Sustainable Design: Ecology, Architecture, and Planning*. Hoboken, New Jersey: John Wiley & Sons, Inc., 2007.
12. Kwok, Alison G. and Walter T. Grondzik. *The Green Studio Handbook: Environmental strategies for schematic design*. Oxford, UK: Architectural Press, 2007.
13. Loughran, Patrick. *Falling Glass: Problems and Solutions in Contemporary Architecture*. Basel: Birkhauser,2007.
14. Hughes, S. David. Chapter 3, “Lighting Fundamentals” and select excerpts from Chapters 4 and 5, in *Electrical Systems in Buildings*. Albany, New York: Delmar Publishers, 1988.
15. Egan, David M. Excerpts from *Architectural Acoustics*. New York: McGraw-Hill, Inc., 1988.
16. Cavanaugh, William J. and Joseph A. Wilkes, editors. Excerpts from *Architectural Acoustics: Principles and Practice.* New York: John Wiley & Sons, Inc., 1999.