ARC 5723 – 901: Applications in Sustainable Design - Spring 2010

Decision Support Tools for Carbon-Neutral Design

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NOTE: This Syllabus is provided for informational purposes regarding the anticipated course content and schedule. It is based on the most recent information available as of the date of its issuance. It is as accurate and complete as is possible at this time. The instructors reserve the right to make any changes deemed necessary and/or appropriate. An effort will be made to communicate any syllabus changes in a timely manner. Students are responsible for being aware of these changes.

Class hours: TR 9:00 to 10:15 a.m.
Location: TBA
Office hours: TR 11:00 a.m. to 12:00 noon or by previous appointment.
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> *"Although architects now generally acknowledge that sustainability is important, many see it as a technical solution without fully understanding the mechanics or worth of green technologies. As a result, the entire industry is abuzz with vague generalizations and valuable principles get reduced to marketing sound bites. …….We posit that sustainable design must put as much emphasis on design as it does on sustainability."*
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> *AIA COTE: Ecology & Design, 2006.*

> *"[Sustainable design is] an approach that holistically and creatively addresses land use, site ecology, community design and connections, water use, energy performance, energy security, materials and construction, light and air, bioclimatic design, and issues of long life and loose fit."*
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> *AIA COTE: Ecology & Design, 2006.*

> *"[Ecological design] is not about making greener widgets but how to make decent communities that fit their places with elegant frugality. The issue is whether the emerging field of ecological design will evolve as a set of design skills applied as patchwork solutions to a larger pattern of disorder or whether design will eventually help to transform the larger culture that is badly in need of reformation."*
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> *David Orr: The Nature of Design, 2002.*

> *"Sustainable design is not limited to simply trying to be more efficient. A new approach offers a clear alternative: an ecologically intelligent framework in which the safe, regenerative productivity of nature provides models for wholly positive human designs . . . we can begin to redesign the very foundations of architecture and industry, creating systems that purify air, land, and water; use current solar income and generate no toxic waste; and use only safe, healthful, regenerative materials. The benefits would enhance all life.*
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> *William McDonough: Teaching Design That Goes From Cradle to Cradle, 2004.*

COURSE CONTENT

This course is based on the premise that there is an increasing need to integrate environmental performance considerations in the form-making processes of architectural design. Such a need responds to and is motivated

by the growing interest of the built environment professionals in achieving a more sustainable and environmentally conscious built environment. While this integration can be achieved through various methods which differ according to the stage of the design process they are intended for, all of these methods aim to inform design decisions by an assessment of the expected performance of the community, building, or building component in question, which is based on measurable criteria such as energy consumption, lighting levels, solar shading and solar access, harmful emissions, or other impacts. Integrating sustainability considerations in the early stages of the design is recognized to be particularly important because of the high impact that design decisions taken in these stages have over the subsequent performance of the building or community especially when aiming for carbon-neutral designs.

Carbon-neutral or 'zero-emissions' buildings or communities can be defined as **EMITTING NO NET CARBON INTO THE ATMOSPHERE THROUGH THEIR OPERATION.** Achieving this goal requires the utilization of both passive design strategies and state-of-the-art energy efficient technologies to design buildings and communities that use much less energy than current practice (up to 50%-80% reductions are possible), and then to incorporate renewable energy generation systems into the fabric of the architecture to cover the remaining demand. Achieving carbon-neutrality is fundamentally a design problem; one that must be solved by intelligent and informed design decisions at every phase of a project. For architectural education, the global imperative of addressing climate change demands a comprehensive response so that design intuition itself is reshaped to reflect this imperative and create hospitable human environments fundamentally through their refined relationship with the natural environment and its forces.

Carbon-neutral design standards represent the future of the building industry, as highlighted by the International Protocol on Climate Change (IPCC), which identifies integrated building design as a "key mitigation technology" that needs to be commercialized before 2030 if we are to avert global climate change. To this end, legislative standards for carbon-neutral buildings are already under development in California and other states, as well as at the Federal level[1].

This course will primarily focus on the application of a wide range of strategies, systems, and technologies typically associated with various aspects of sustainable design to achieve carbon-neutral buildings and communities. Several state-of-the-art design decision support and environmental performance simulation tools, currently used by practitioners and/or researchers, will be introduced as a means of informing sustainable and carbon-neutral designs. The course will provide opportunities for students to have hands-on experiences in using these tools, which they can then utilize in their future academic and professional design activities. These hands-on exercises will also be used to demonstrate how sustainable design practices can reduce the negative environmental impact of the built environment, while providing more comfortable, healthy and economical buildings and communities.

The course will cover a wide range of topics, related to achieving carbon-neutral buildings and communities, including the definition(s) of sustainability, sustainable design, and carbon neutrality; climate analysis and climatic design strategies; building envelopes and indoor thermal environment; human thermal comfort; passive and active design strategies for different climatic regions; shading and solar access; passive and low-energy sustainable systems and technologies; daylighting; life-cycle analysis of sustainable building materials and systems; whole building energy use and building energy efficiency; ventilation and indoor and outdoor environmental quality; and sustainability assessment methods and frameworks.

THE CARBON-NEUTRAL STUDIO INITIATIVE

This course is being conducted as part of the "***Carbon-Neutral Studio Project (CND)***". This initiative is a collaborative research effort consisting of a network of more than 30 studio faculty from 26 North American schools of architecture who currently teach design studios or courses with carbon neutrality as a theme. The project involves conducting a survey of teaching methods of carbon-neutrality at different schools across north America. Student work from the Spring 2008 course was exhibited in a project conference in Boston MA in November 2008 and will be included in an AIA publication about the CND project.

[1] James Wasley, 2007, Carbon Neutral Studio Project Proposal, University of Wisconsin-Milwaukee.

As part of this initiative, this course investigates the teaching of carbon-neutrality in design studios through a studio-seminar model in which course participants will be teamed up with students in a concurrent design studio to form integrated design teams in which students from the course will perform the role of the environmental performance consultant. In this capacity, course students will be responsible for utilizing the tools presented in the course in performing all the necessary analysis, modeling, and simulation required to inform the design decisions of the team.

COURSE STRUCTURE AND ACTIVITIES

This course will involve a variety of activities including readings, lectures, discussions, demonstrations and hands-on exercises of sustainable building design tools, a semester project, and a research paper. Readings are a major component of the course and relevant articles, reports, and/or book chapters will be assigned which will provide a background for the lectures and the related discussions sessions. A list of assigned readings will be provided and, as much as possible, these assigned readings will be made available in a digital format (PDF) on WebCT. Lectures and presentations will be conducted by the instructor to present the theory and principles behind the topics covered in the course as well as to demonstrate the capabilities of the modeling and simulation tools utilized in the class. Hands-on exercises in which students will utilize these tools will also be conducted and will form components of the semester project discussed below.

PROJECTS AND ASSIGNMENTS

READINGS & DISCUSSIONS:

Readings will be assigned on topics related to the objectives of the course. For each assigned reading topic, students will submit a brief review of the readings (no more than 250 words, or one page), which both summarizes their understanding of the material and presents their position with regard to the topic being discussed. The summary will be submitted before the beginning of each class having assigned readings using WebCT. Strong and effective participation in discussion sessions based on the readings is expected from all students and will be considered part of the course evaluation.

INTERIM EXERCISES AND SEMESTER PROJECT

During the course of the semester, several assignments and hands-on exercises will be conducted in which students will apply sustainable design principles and strategies to a specific design project through utilizing the variety of performance modeling and simulation tools addressed in the class, therefore gaining experience in using these tools. A written brief will be provided by the instructor for each of the assignments comprising this project as well as the requirements of the final submission. Due dates for the assignments are included in the course schedule. The design project forming the basis of these exercises will be selected following one of the three options described below. Each student will select one of the options and inform the instructor of their selections during the first week of the semester. The options are:

Option A: In this option, students will be teamed up with students in a concurrent design studio to work as a collaborative team. While not being responsible for the quality of the resulting design, students from the course will play the role of the environmental performance consultant within an interdisciplinary design team and will therefore be responsible for conducting the necessary analysis and performance simulation needed to inform the design tam members using the tools presented in the course. Students selecting this option will be eligible to participate in the carbon-neutral studio project.

Option B: This option is possible for students taking concurrent design studios. In it, students will adopt carbon neutrality as an additional objective for their studio design project (in addition to all other objectives that may be assigned to them by their studio instructors) and will utilize the tools

presented in the course to conduct the analysis and simulation necessary to inform their design decisions. While the course tasks should not interfere with any other requirement of the design studio in this option, students are strongly encouraged to discuss this option with their studio instructors.

For each of the options listed above, the final outcome of this semester project, to be submitted at the end of the semester, will consist of:

1- A 24" x 36" board including a graphical representation of the results of the different exercises performed during the semester. The board should be designed as a part of the overall final presentation of the design project but should also have the possibility of being presented as a stand-alone poster presentation.

2- A report which includes a description of the design project (in both written and graphic forms), results of each of the assignments and the design recommendations and/or modifications performed based on each of them, and finally, a description of the final design and the resulting performance including documentation of the achievement of carbon-neutrality.

TERM RESEARCH PAPER

Each student is required to submit a term paper at the end of the semester representing a graduate-level, in-depth exploration of a specific topic relating to issues of sustainability or sustainable design. The instructor will provide students with a list of suggested topics to select from. Deadlines for selecting a topic ae included in the term schedule. Midway through the semester, each student will have the opportunity to conduct a one-on-one session with the instructor to explore their suggested structure for the paper and the resources available for it. Final papers must be typed and will be no more than 3000 Words in length (approximately 10 pages of text) and may include high-quality graphics. Papers should strictly follow scientific writing styles and information included in it must be accurately cited and a comprehensive reference list and/or bibliography must be included. Papers will be submitted both digitally (PDF format) and as a hard copy.

Students will also present the topic of their paper to the whole class at the end of the semester and copies of all presentations will subsequently be made available to all students in the class through webCT.

EVALUATION & GRADING POLICY

Evaluation in this course will involve a number of components including: reading summaries, course project (including assignments and hand-on exercises), research paper, attendance, and participation in discussions. Extra credit may be assigned during the semester. The breakdown of the course evaluation is as follows:

- Reading summaries 10%
- Interim assignments and exercises 20%
- Final Semester Project 40%
- Term paper: 20%
- Attendance and participation: 10%

- Total: 100%

GRADING POLICY

The general meaning of the letter grades is presented below:

A (90-100) ***Excellent:*** Exceeds minimum requirements and reaches a state of exceptional work produced. Exhibits strong initiative, attendance, participation, research and reading. Complete comprehension of course/project goals. Adds positively to the educational experience of the rest of the class. Projects, papers, and assignment are delivered by the due date and are of exceptional written and graphic quality.

B (80-89) ***Good:*** Often exceeds minimum requirements for work produced – for quality and quantity, attendance, research and reading. Participates regularly in class discussions. Solid comprehension and above average demonstration of course/ project goals. Projects, papers, and assignments are delivered by the due date and are of good written and graphic quality.

C (70-70) ***Average:*** Meets minimum requirements for work produced – for quality and quantity, attendance, research and reading. Little or no participation in class discussions. Projects, papers, and assignments are delivered by due date and are of average or acceptable informational and graphic quality.

D (60-69) ***Poor :*** Work produced is consistently weak with poor craft, absences, insufficient or no research, little or no reading, little or no participation. Demonstrates a weak comprehension of course/ project goals. Projects, papers, and assignments, if delivered by the due date, are of poor informational and graphic quality.

F (below 60) ***Unacceptable:*** Work, if any, produced is very weak with poor craft, 4 or more absences, little or no research, reading, and participation. Demonstrates that course/ project goals or test questions were misunderstood or ignored. Projects, papers, and assignments, if delivered by the due date, are of unacceptable written and graphic quality.

COURSE POLICIES

ATTENDANCE:

Course attendance is mandatory and is considered an integral component of the learning experience. Punctuality is required and considered an indication of professionalism and responsibility. A maximum of ONLY THREE UNEXCUSED ABSENCES are allowed during the semester without affecting the final course grade. The final grade will be reduced by a full letter grade for each additional day of unexcused absence. Excused absences must be arranged for beforehand with the instructor as much as possible (e-mail will be acceptable) and the required documentation should be provided as soon as possible afterwards; otherwise, they will count as unexcused absences.

LATE SUBMISSION:

Late submission of projects and assignments is not allowed. Students with excused absences, who will not be present to meat a submission deadline, should consult with the instructor beforehand to make alternative arrangements for submitting their work on time. No exceptions will be made. Late submittals of projects or assignments will result in a reduction in the grade of the assignment in question by 10 points (or a full letter grade) for each CALENDAR DAY. No excuses will be accepted for late submissions. All submittals are due at the BEGINNING of class at the due date unless otherwise announced.

WEBCT (CE6):

All course material, including syllabus, class presentations, projects and assignment briefs, and other resources, will be made available on WebCT. WebCT mail will also be used by the instructor to communicate important information to students. Students are responsible to check their WebCT mail account regularly or forward it to a main e-mail account they do check regularly. Student grades will also be posted on WebCT as they become available.

COURSE TOOLS AND SOFTWARE

The course will introduce several state-of-the-art digital modeling and simulation tools being used by researchers and practitioners all over the world to inform their design processes. All efforts will be made to have all of these tools available on the computers in the architecture lab as soon as possible. Additionally, most of these tools are either freeware or shareware and can therefore be downloaded free of charge from the internet to be used on students' personal computers if needed and students are encouraged to take advantage of that as much as possible. Information about the sources of these tools and the download/installation procedures will be provided by the instructor during the semester.

The course will utilize one commercial tool, ECOTECT (http://ecotect.com/), which represents the latest advances in building environmental performance modeling and simulation. Full versions of this tool ARE AVAILABLE on the architecture lab computers. Fully functional demo versions of the software are also available free of charge but have no possibility of saving the outcomes. Interested students should contact the instructor for more information.

BUILDINGGREEN.COM

The BuildingGreen.com Suit is an online resource featuring comprehensive, practical information on a wide range of topics related to sustainable building--from energy efficiency and recycled-content materials to land-use planning and indoor air quality. The suite integrates online versions of ***GreenSpec***, ***Environmental Building News***, and a database of more than 160 high-performance building case studies. Students interested in taking advantage of this offer should email the instructor for detailed subscription instructions. BuildingGreen.com will be available through the UTSA library website at the beginning of the spring semester. Contact the instructor for additional information.

RECOMMENDED TEXTS

There are NO REQUIRED TEXTS for this course. Assigned readings, if not available on-line or through the library, will be made available in PDF format on WebCT. However, the following is a recommended general reading list that can provide you with a more in-depth understanding of the topics covered in the course.

Ander, G. 1995. *Daylighting Performance and Design*. New York, NY: Van Nostrand Reinhold.

Baker, N. and Steemers, K. 2000. *Energy an Environment in Architecture*. London, UK: E & FN Spon.

Brown, D.; fox, M.; and Pelletier, M. (eds.) 2005. *Sustainable architecture White papers*. New York, NY: Earth Pledge.

Brown, G. and Dekay, M. 2002. *Sun, Wind, and Light, 2nd edition.* New York, NY: John Wiley & Sons.

Buchanan, B. 2006. *Ten Shades of Green*. The Architecture League of New York. Available Electronically at: http://www.archleague.org/tenshadesofgreen/10shades.html

Stein, B. and Reynolds, J. 2005. *Mechanical and Electrical Equipment for Buildings, 10th edition*. New York, NY: John Wiley & Sons.

Guzowski, M. 2000. *Daylighting for Sustainable Design*. New York, NY: McGraw Hill Inc.

Harvey, L. D. 2006. *A Handbook on Low-Energy Building and District Energy systems*. London, UK: Earthscan.

Kwok, A. and Grondzik, W. 2007. *Green Studio Handbook, Environmental Strategies for Schematic Design.* Oxford, UK: Architectural Press.

McDonough, W. and Braungart, M. 2002. *Cradle to cradle: Remaking the Way We Make things*. New York, NY: North Point Press.

Orr, D. 2002. *The Nature of Design: Ecology, Culture, and Human Intention*. New York, NY: Oxford University Press.

The European Commission. 1999. *A Green Vitruvius: Principles and Practice of Sustainable Architectural Design.* London, UK: Earthscan Publications.

Yeang, K. 1995. *Designing with Nature: The Ecological Basis for Architectural Design.* New York, NY: McGraw Hill Inc.

ON-LINE RESOURCES

AIA Committee on the Environment (COTE): http://www.aia.org/cote_default
American Sola Energy Society (ASES): http://www.ases.org/
Building Energy Software Tools Directory: http://www.eere.energy.gov/buildings/tools_directory/
Building Environmental Quality Evaluation for Sustainability through Time (BEQUEST): http://research.scpm.salford.ac.uk/bqtoolkit/index2.htm
Center for Alternative technology (CAT): http://www.cat.org.uk/
Center for Maximum Potential Building Systems: http://www.cmpbs.org/
Development Center for Appropriate technology: http://www.dcat.net/
DOE2: http://www.doe2.com/
Energy Design Resources: http://www.energydesignresources.com/index.php
Energy Information Administration (EIA): http://www.eia.doe.gov/
Energy Star Program: http://www.energystar.gov/
Environmental Building News: http://www.buildinggreen.com/
Green Builder: http://www.greenbuilder.com/
Green Building Materials: http://oikos.com/green_products/index.php
International Code Council (ICC): http://www.iccsafe.org/
Lawrence Berkeley National Laboratory (LBNL) Windows and Daylghting Group: http://windows.lbl.gov/
Metropolitan Partnership for Energy: http://www.mp4e.nfo
Rocky Mountain Institute (RMI): http://www.rmi.org/
San Antonio Sustainable Building Coalition: http://www.buildsagreen.org
Solar Decatholon: http://www.eere.energy.gov/solar_decathlon/
Smart Communities Network: http://www.smartcommunities.ncat.org/
Smart Growth Network: http://www.smartgrowth.org/Default.asp?res=1280
Square one: http://www.squ1.com/
Sustainable Buildings Sourcebook: http://www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Building/Sourcebook/index.htm
Sustainable Communities Network: http://www.sustainable.org/
Sustainable Habitat Design Advisor (SHADA): http://www.sustainable-buildings.org/
US Green Building Council (LEED): http://www.usgbc.org/
US Department of Energy (DOE) Energy Efficiency and Renewable Energy (EERE): http://www.eere.energy.gov/
Whole Building Design Guide http://www.wbdg.org/

SCHOLASTIC DISHONESTY

Scholastic dishonesty or plagiarism *WILL NOT BE TOLERATED* in this class. Any such incident will result in automatic failure in the project or assignment involved. Any and all incidents of plagiarism and academic dishonesty will be reported to the Office of Student Life. For more details, please refer to the Scholastic Dishonesty Policy as stated in the current University Catalogue.

STUDENTS WITH DISABILITIES

The Americans with Disabilities Act (ADA) is a federal anti-discrimination status that provides comprehensive protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you need accommodation related to a disability, please make an appointment to discuss your needs.