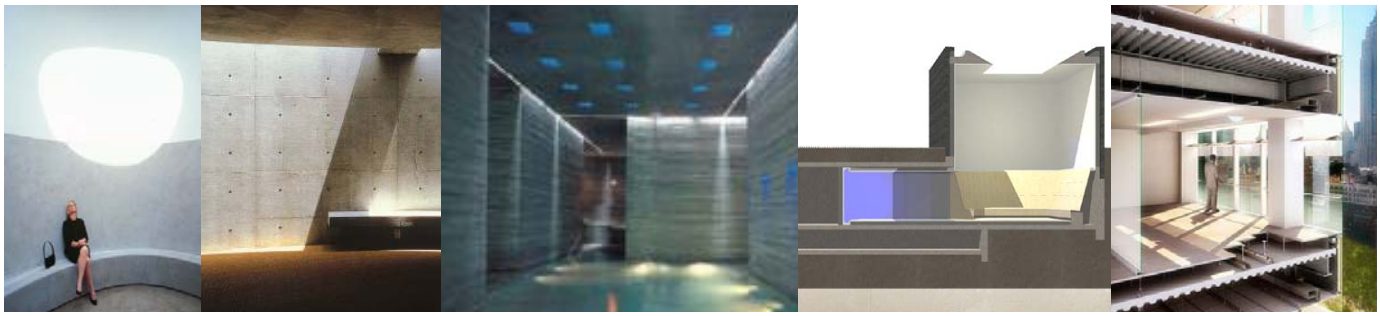
A R C H 5 5 1 6 • L U M I N O U S A N D T H E R M A L D E S I G N

Technology Two

6 credits (6.5 weeks); NAAB Criteria: 15, 18

An Ecological Approach to Zero-Energy Carbon Neutral Design



How sense-luscious the world is. In the summer, we can be decoyed out of bed by the sweet smell of the air soughing through our bedroom window. The sun playing across the curtains gives them a moire effect, and they seem to shudder in light, someone might hear the dawn sound of a cardinal....We need to return to feeling the textures of life.
Diane Ackerman, A Natural History of the Senses

The building should tell a story about place and people and be a pathway to understanding ourselves within nature. *Sim Van der Ryn*

Instructors

ARCH 5516: Luminous and Thermal Design

Mary Guzowski, Associate Professor, School of Architecture
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Office hours: Wednesday, 12:30-1:30 or by appointment, Room 145B

Loren Abraham, AIA, LEED AP, Adjunct Assistant Professor, Abraham + Assoc,
Phone: 651.480.2237; E-mail: abrah221@umn.edu
Office hours: Friday, 12:30-1:30 PM or by appointment, check for location

If you cannot make these office hours please see the instructors after class to make an appointment. Office hours can be used to discuss course work, review work in-process, get additional readings, or to talk about the subject matter in relation to your special interests.

Teaching Assistants

The TAs are available to assist you with projects and lab work. Please take advantage of their office hours to clarify information and to review your work in-process.

C O U R S E D E S C R I P T I O N

Courses

ARCH 5516: Luminous and Thermal Design Integration

This semester you are asked to consider how architectural design can respond to the growing ecological challenges of global warming and climate change. While there are many issues related to carbon neutral and zero energy design, this investigation will focus on the roles of daylighting, thermal, and bioclimatic considerations to meaningfully inform architectural design while also reducing fossil fuel consumption and greenhouse gas emissions. Your challenge is to design a third floor addition to "old Rapson Hall" for the new "Minnesota Zero-Emission/Zero-Energy Design Lab" (mnZED Lab) for the College of Design. The design project will enable students to gain firsthand experience

of the phenomena of thermal and luminous designs and their ecological design opportunities. Direct application of concepts, strategies, and principles as well as qualitative and quantitative assessment, and testing will be considered.

Course Focus:

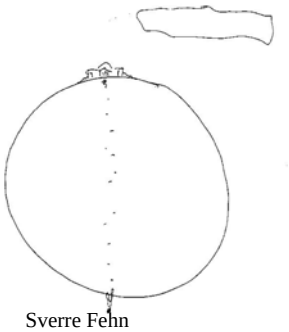
Luminous and Thermal Design for Zero Energy Carbon Neutral Architecture

ARCH 5516: Luminous and Thermal Design introduces the ecological design concepts and principles of daylighting, thermal, energy, and systems integration. The courses will provide students with an understanding of the primary architectural and technological implications of lighting and thermal to inform design and ecological thinking and to support sustainable design decision-making. An integrated approach to the courses topics will be explored from a variety of perspectives to address the following course objectives:

Course Objectives

The objectives of the courses:

1. Ecological and Holistic Systems Thinking: To provide students with daylighting and thermal design processes and integrated tools that enable them to evaluate, assess, and apply an holistic approaches to zero energy carbon neutral design.
2. Formal, Aesthetic and Experiential Design Opportunities: To introduce students to the formal, aesthetic, and experiential opportunities of an ecological approach to daylighting, thermal, and systems integration in design.
3. Ecological and Technological Design Opportunities: To introduce students to the ecological and technical concepts, principles, and strategies of daylighting, thermal, energy, and systems integration for zero energy carbon neutral design.
4. Appropriate Technology and Multi-functionality: To learn to employ technology appropriately to achieve optimal results and long term cost and ecological effectiveness.
5. Performance Assessment Methods and Testing: To introduce and apply qualitative and quantitative methods and design tools for assessment, testing, and performance analysis for an ecological approach to zero energy carbon neutral approaches to luminous and thermal design.



Sverre Fehn

Course Work

PROJECTS, GRADING, AND EXPECTATIONS

The course will include three design projects, which enable students to assess and apply concepts, strategies, and assessment methods through direct application to design. Projects are *tentatively* weighted accordingly:

PROJECTS

Project One: Site and Bioclimatic	*no grade*
Project Two: Daylighting Design	*25%*
Project Three: Thermal Design	*25%*
Project Four: Ecological Envelopes	*no grade*
Project Five: Experiencing Sustainability	*10%*
Project Three: Integrated Design	*40%*
TOTAL	*100%*

All projects are due at the beginning of class on the project due date (or it will be considered late). Late projects will be lowered one grade for each calendar day that it is late (i.e. from an A to A- if it is submitted late on the due date, from an A to a B+ if it is submitted the day following the due date, etc.). *All design charettes and projects must be completed to receive a passing grade.*

Grading Standards

University of Minnesota Grading Standards:

A Achievement that is outstanding relative to the level necessary to meet course requirements
B Achievement that is significantly above the level necessary to meet course requirements
C Achievement that meets the course requirements in every respect
D Achievement that is worthy of credit even though it fails to meet fully the course requirements
SAchievement that is satisfactory, which is equivalent to a C- or better
F (or N) Represents failure (or no credit) and signifies that the work was either: 1) completed but at a level of achievement that is not worthy of credit or 2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an incomplete.
I (Incomplete) Assigned at the discretion of the instructor when, due to extraordinary circumstance, e.g., hospitalization, a student Is prevented from completing the work of the course on time. Requires a written agreement between instructor and student.

Collaboration

You will be working on a collaborative project, which will include individual and group grading. You are asked to form groups which include a combination of students in the M.Arch 3+ Program and those graduating from the B.S. Program. We also ask that students who use Macintosh computers form groups with students working with PC platforms (in case Ecotect becomes accessible for purchase during the semester - Ecotect is PC only).

Academic Dishonesty

Academic dishonesty in any portion of the academic work for a course shall be grounds for awarding a grade of F or N for the entire course.

Credit/Workload Expectations

This 6 credit course will run for 6.5 weeks. The expected workload for this course provided by the School of Architecture and based on University standard is an estimated total of 42 hours per week. This can include any combination of time in the class or outside the class. We will work with students to assess the workload and make adjustments as needed.

Schedule and Attendance

The courses meet on Monday, Wednesday, and Friday mornings and afternoons in either room 54 Rapson Hall, the courtyard, or studio. A detailed daily schedule will be provided. Attendance is required. It is critical that you fully participate and attend all class periods (lectures, reviews, and field studies). Please make every effort to be to class on time. Punctuality is important in maintaining and building community and as a means of minimizing class disruptions.

Supporting Material

R E A D I N G

Suggested Text

- Kwok, Alison and Walter Grondzik. *The Green Studio Handbook*. London: Architectural Press, 2007.
- Lechner, Norbert. *Heating, Cooling, Lighting: Design Methods for Architects*, New York, Wiley, 2001.

Required Software

ECOTECT version 5.50; educational license; Square One Research, Dr. Andrew Marsh, 2005.

Required Reading List

Specific readings will be assigned with the individual course projects in 1-2 week blocks. All readings are on *electronic reserve* through the University of Minnesota library system. Listed at the end of the syllabus are reference books on daylighting, thermal, and systems integration that are on reserve in the College of Design library for your reference (please see last page of syllabus).

"A phosphorescent jewel gives off its glow and color in the dark and loses its beauty in the light of day. Were it not for shadows, there would be no beauty." *Jun'ichiro Tanizaki, In Praise of Shadows*

ARCH 5516 Tentative Schedule

Green: integrated; Blue: daylight focus; Yellow: thermal focus; Orange: Computer; Purple: fieldwor

	Monday		Wednesday		Friday
Week 1			**INTEGRATED ZED & LOW ENERGY DESIGN: PROBLEM & GOALS**		**PASSIVE: Bioclimatic design - integrated climate, site, thermal, and light**
.		Optional Design Critiques	**Introduction ZED concept and goals:** setting targets and loads Computer 1: climate tools; solar tool; basic modeling	Optional Design Critiques	**Site and Bioclimatic Design** Computer 2: intro daylight 1: daylight analysis
Week 2	**PASSIVE: daylight strategies and program**		**PASSIVE: daylight strategies and program**		**PASSIVE: daylight strategies and program**
	PROJECT ONE REVIEW: Bioclimatic Charette Daylight Strategies: form, section, massing Computer 3: daylight 2: daylight analysis	Optional Design Critiques	**Poetics of Light;** liuminous comfort, quality, and human experience; windows Computer 4: solar control and shading	Optional Design Critiques	**Daylight Program and Human Response**; Quantitative and qualitative analysis
Week 3	**PASSIVE: daylight strategies and program**		**LOADS AND PASSIVE: Thermal**		**ENVELOPE: Thermal**
	Dayliglht Ecotect Due Computer 5: thermal 1: basic model construction, zones, objects and zone settings	Optional Design Critiques	**PROJECT TWO REVIEW: DAYLIGHT Passive Design and Building Loads Pt. 1** Computer 6: thermal 2: editing zones, changing material properties, schedules	Optional Design Critiques	**Passive Design and Building Loads Pt. 2** **FIELDSTUDY: Central Library;** thermal and daylight integration
Week 4	**ENVELOPE: Solar control and shading**		**ENVELOPE: Thermal**		**ENVELOPE: Thermal**
	Envelope Design Part 1: Skin and Glazing: Wall and roof systems, Controlling moisture*)*	Optional Design Critiques	**Envelope design part 2:** troubleshooting for the envelope parametric studies due Friday.) Computer 7: parametric studies envelope	Optional Design Critiques	**Intelligent Skin**: Building Integrated PV (BiPV) and BIPV Computer 8: solar control and shading + envelope
Week 5	**INTEGRATION**		**SYSTEMS: Daylight and electric design**		**SYSTEMS: Daylight and electric design**
	PROJECT THREE REVIEW - THERMAL Ecological envelopes: fivefold functionality Computer 9: solar control	Optional Design Critiques	**Renewable energy:** sizing and design guidelines for solar thermal and PV Computer 10: solar collectors	9:30-11:30: Optional Design Critiques)	**PROJECT FOUR REVIEW: Envelope Studies** **Intro: Poetics of Light** **FIELDSTUDY: Bigelow Chapel:** daylighting and electric lighting integration
Week 6	**SYSTEMS: Thermal + renewable energy systems**		**SYSTEMS: Thermal + renewable energy systems**		**SYSTEMS: renewable energy systems – carbon calculations**
	Intro to Building Systems: HVAC systems, Controls, Building Automation Renewable Energy	Optional Design Critiques	**PROJECT FIVE REVIEW: Experiencing Sustainability** (Daylight+Thermal Room Studies) **Electric Lighting Design** Rapson Library Fieldstudy: Daylight and Electric Integration Computer 12: windflow physical models	Optional Design Critiques	**Renewable Energy Systems Integration Pt.2**; Getting to Zero – Carbon Calculations Computer 12: troubleshoot
Week 7	**INTEGRATION**		**INTEGRATION**		**INTEGRATION**
	Due: Carbon calculation exercise Optional Design Critiques Computer13:troubleshoot	Optional Design Critiques	Optional Design Critiques Computer 14: troubleshoot	: Optional Design Critiques	**PROJECT SIX REVIEW:** Zero Energy Carbon Neutral Design Integration

ARCH 5516•LUMINOUS AND THERMAL DESIGN

REFERENCE BOOKS ON RESERVE

The following books are on reserve for your reference in the CDes Library

DAYLIGHTING DESIGN

- Baker, N.V, Fanchiotti, A., and K. Steemers, editors. *Daylighting in Architecture: A European Reference Book.* London: James & James, 2001.
- Deutsches Architektur Museum, editor. *The Secret of the Shadow: Light and Shadow in Architecture.* Germany: DAM, 2002.
- Gannon, Todd, editor. *The Light Construction Reader.* New York: The Monacelli Press, 2002.
- Guzowski, Mary. *Daylighting for Sustainable Design.* New York: McGraw-Hill, 2000.
- Herzog, Krippner, and Lang. *Façade Construction Manual*, Basel: Birkhäuser Publishers, 2004 (please browse – excellent reference).
- Illuminating Engineering Society of North America (IESNA). *The IESNA Lighting Handbook*, New York: IESNA, 2000.
- Meyers, Victoria. *Designing with Light.* New York: Abbeville Press Publishers, 2006.
- Millet, Marietta. *Light Revealing Architecture.* New York: Van Nostrand Reinhold, 1996.
- Richards, Brent. *New Glass Architecture.* New Haven: Yale University Press, 2006.
- Schittich, Christian, editor. inDETAIL: *Solar Architecture.* Basel: Birkhäuser Publishers, 2003.
- Klaus Daniels, *Low-tech Light-tech High-tech*, Basel: Birkhauser, 2000.

ELECTRIC LIGHTING DESIGN

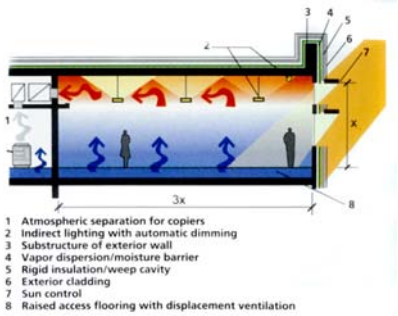
- Byars, Mel. *50 Lights: Innovations in Design and Materials.* Switzerland: RotoVision, 1997.
- Egan, David M. and Victor Olgyay. *Architectural Lighting, second edition.* New York: McGraw-Hill, 2002.
- Gardner, Carl and Barry Hannaford. *Lighting Design: An Introductory Guide for Professionals*, New York: John Wiley & Sons, 1993.
- Steffy, Gary. *Architectural Lighting Design, second edition.* New York: John Wiley & Sons, 2002.
- Thaureau, Vanessa. *Ultimate Lighting Design*, New York: teNeues, 2005.

ENVELOPE DESIGN (Daylight and Thermal Issues)

- Balkow et al. *Glass Construction Manual*, Boston: Birkhäuser, 1999.
- Compagno, Andrea. *Intelligente Glasfassaden : Material, Anwendung, Gestaltung : Intelligent Glass Facades: Material, Practice, Design*. Boston : Birkhauser-Verlag, 2002.
- Schittich, Christian, editor. *Building Skins.* Basel: Birkhäuser Publishers, 2001.
- Schittich, Staib, Balkow, Schuler, and Sobek. *Glass Construction Manual.* Basel: Birkhäuser Publishers, 1999.
- Wigginton, Michael and Jude Harris. *Intelligent Skins*, Oxford: Butterworth-Heinemann, 2002.

THERMAL AND SYSTEMS DESIGN

- Abraham, Loren E. (adaptation) and Thomas Schmitz-Gunther, editor. *Living Spaces: Ecological Building and Design* Cologne, Germany : Konemann Verlag., 1999.
- Allen, Edward. *Fundamentals of Building Construction*; 3rd ed.; New York : Wiley, 1999.
- Brand, Stewart; *How Buildings Learn: what happens after they're built*, New York, NY : Viking, 1994.
- Brown, G.Z., Mark DeKay. *Sun, Wind & Light*; 2nd ed., New York : J. Wiley, 2001.
- Mazria, E. *The Passive Solar Energy Book*. expanded professional edition. Emmaus, PA, Rodale Press, 1979.
- Stein, B., J. Reynolds, W. Grondzik, and A. Kwok. *Mechanical and Electrical Equipment for Buildings*, 10th Ed., Wiley, 2006.



Integrated design is about bringing together all key members of the project team to work collectively across disciplines. "The collective knowledge is far greater than the individual knowledge."

- John Broecker, L. Robert Kimball & Associates