**Use**

The design for the Center for Sustainable Building Research (CSBR) must meet four goals.

First, it must provide space to house research and education for Zero Energy Design (ZED).

Second, the building will be a showcase of two different approaches to ZED and an opportunity to test these two strategies.

Third, the building will bring out the poetics of these two strategies and the dialogue between them.

Fourth, the design will be respectful and attempt to improve the conditions of the existing Rapson Hall, improve daylighting in the courtyard, and provide additional crit and lounge space.

**Site**

**Context**

The site, located atop Rapson Hall, is a part of the greater community of the University of Minnesota - Twin Cities Campus.

**Windrose Charts**

Exposure to the cool winter breezes from the Northeast should be minimized. Passive cooling can be benefitted from the southern summer breezes.

**Sun Path Studies**

Low sun angles affect solar access in the winter, making direct gain strategies inappropriate for specific areas (North side of the site).

**Degree Days**

Low temperatures throughout most of the year emphasize the need efficiently heat the building and minimize heat loss.

**Technology**

**East-West Orientation**

Kroon Hall
Yale University
New Haven, Connecticut
Hopkins Architects

**Double Envelope**

Double Envelope House
Lake Tahoe, California
Lee Porter Butler

**Passive House**

BioHaus
Concordia University
Bemidji, Minnesota
Stephen Tanner
Intep LLC
CONCEPTS

- **Concept**
- **Program**
- **Circulation**
- **Classrooms**
- **Admin. Labs**
- **Outdoor Space**

**Skin/Materials**

- Extensive Green Roof
- R-70 Insulation
- Northern-Exposure Clerestory
- Zinc Exterior Cladding
- R-50 Insulation
- Public Boardwalk
- Prairie Grass
- Diffused Skylights
- Triple-Pane Low E
- Double Envelope
- R-50 Roof
- R-30 Walls
- Clear Pane/Louver System
LUMINOUS DESIGN

Poetics

Daylighting Program

Target Illuminance Levels

Usable Daylight

The most utilized spaces within the CSBR Lab achieve a usable daylight illuminance without the assistance of electric lighting 75–100 percent of the time.

Daylight Strategies

The South Wing utilizes skylights in conjunction with a ceiling layer that diffuses light into the labs. Direct light filters through the louvers into the corridor.

The North Wing takes advantage of northern light due to its poor direct solar access.

Electric Light Strategies

The South Wing contains ambient electric lighting in the labs. Task lighting sufficiently illuminates the work surfaces, including pin-up boards in the corridor.

The North Wing has ambient light sources embedded in the ceiling plane, as well as task lighting for presentations in the corridor.
This study carefully examines the experiential qualities within the lab spaces in relation to material selection, daylight control, and overall character of space. The partition wall between the lab and the corridor was the independent variable. The control study examines the space with no partition wall included in the space.

### Parametric Studies

#### Results

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<th>Time</th>
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<th>Spring</th>
<th>Summer</th>
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### South Corridor

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### Usable Daylight

The Research Labs achieve a usable daylight illuminance, without the assistance of electric lighting, 60-100 percent of the time.
**Passive/Active Systems**

**Summer Conditions**

The South Wing contains operable windows that allow cross ventilation across the occupied space. The North Wing has vents in the overhangs that draw natural air into the raised floor and through the classrooms. A forced air system is used when passive solutions are insufficient.

**Winter Conditions**

The South Wing utilizes direct solar gain in the corridor. Both wings contain radiant floor heating, fueled by a solar thermal system.

**Conclusions**

The initial baseline design performed at 128.2 kBtu/ft². In order to improve the performance of the building, passive daylight and thermal strategies were integrated into the design. Specifically, the design divided the program into two compact wings; the North Wing acting as a thermal barrier and the South Wing taking advantage of solar access. These passive strategies, combined with active heating and cooling systems and supplemented with renewable energy, allowed Zero Energy Design to be achieved.

**Building Energy Use**

- **Load Type**
  - Total Area Heating Load (kBtu): 261,064
  - Total Area Cooling Load (kBtu): 56,163
  - Total Area Lighting Load (kBtu): 59,045
  - Total Area Equipment Load (kBtu): 77,213

- **Site Energy Use** (kBtu)
  - 1,106,594

- **Final Energy Use Intensity** (kBtu/SF)
  - 95.5

- **Total Energy Use (kBtu)**
  - 1,828,783

**Renewable Energy**

- **PV production (kWh)**: 264,527
- **Total Renewable Energy Production**: 1,108,594

**Final Analysis**

**Baseline Final Energy Use Intensity**: 128.2 kBtu/ft²

**Final Energy Use Intensity**: 0 kBtu/ft²