Atelier Ten – Daylight Case Studies
Radiance Workshop 2013
Golden, CO

Jessica Zofchak
Senior Environmental Designer
A legacy of positive change
We are an international team of environmental design consultants and lighting designers focused on delivering sustainability to the planned and built environment.
Practice Principles

- Buildings and landscapes do more, systems do less
- Design from first principles
- Integrated design process and solutions
- Pragmatic strategies
Strategy

- Establish sustainability goals early
- Set performance targets
- Develop and test design strategies
- Select technologies to support strategies
- Monitor progress against benchmarks
Services

- Environmental Design
- Energy Analysis
- Lighting Design
- Masterplanning
- Benchmarking
- Carbon Management
- Façade Optimization
High Performance Facades
Case Studies

- Façade optimization using DIVA for Rhino and Grasshopper
- Daylight design for vegetation
Façade Optimization – MSKCC/CUNY
Urban Context Façade Optimization

Project Team:
Architect: Ennead Architects
Envelope Consultant: Heintges
Environmental Consultant: Atelier Ten
Mechanical Engineer: JB&B
Overshadowing

South Facade

Setback is more shaded:
- Summer sun from 10AM-2PM
- Spring, fall, winter sun from 2:30AM-1PM

Lower South Facade is fully shaded throughout the year

1. CUNY Upper South Facade (Labs)
   - Summer: Sun after 10AM
   - Spring/Fall/Winter: Sun from 9AM-11AM, 11:30AM-1PM

2. CUNY Lower South Facade (Offices)
   - Summer: Sun from 10AM-11AM, 11:30AM-1PM
   - Winter: Sun from 7AM-9AM, 11AM-1PM, 2-4PM

3. MSK Upper South Facade
   - Summer: Sun all day
   - Spring/Fall/Winter: Sun until 12:30PM

4. MSK Mid-West South Facade
   - Summer: Shade for 1 hr around noon
   - Spring/Fall: Sun from 8AM-10AM, 1-4PM
   - Winter: Sun before 11AM and after 3PM

5. MSK Mid-East South Facade
   - Summer: Sun from 6AM-12:30PM
   - Spring/Fall: Sun from 6AM-12:30PM
   - Winter: Sun until 1PM

6. MSK Lower South Facade
   - Summer: Sun from 10:30AM-11:30AM, 2-4PM
   - Spring/Fall: Sun from 9AM-11AM, 3-5PM
   - Winter: Sun until 11AM

East Facade

East Elevation

East Facade overshadowing:
- Summer: Sun until 1PM
- Winter: Sun until 2PM
Solar Insolation Bands (100 kWh/m² increments)

North façade used as target solar radiation level
Curtain Wall System

Glass lite widths:
1’-6”
3’-0”
4’-6”
### External Shading Studies

**GLAZING PANEL ANALYZED (PLAN VIEW)**

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**Recommended Vertical Fin Depth Combinations for Left and Right Fins**
**Grasshopper Process – Radiation Analysis**

**A10 Radiation Component**
- Standard component introduced before
- Different visual output options
- Excel output options

**Excel Post processing**
- Takes input from Grasshopper
- Allows additional post processing abilities
- Formats data in our standard layout
Grasshopper Process – Fin deployment

**Input**
- Radiation data
- Fins
- Fin chart

**Output location**
Grouping of existing fins

**Output processing**
Grouping of fins based on solar radiation analysis

**Output**
Fins in different layers according to radiation bands
Baseline – Recommendation Comparison
Analysis with recommended fin depth
Baseline – Recommendation Comparison
Analysis with recommended fin depth
Fin Optimization Summary
Vertical Fin Options Tested

![Bar graph showing annual solar radiation (kWh/m²) for different fin options and glass panel widths on the south and east facades.](image)

**South Facade**
- 3' 800-900 kWh/m² (Orange): -16.4%
- 1'6" 700-800 kWh/m² (Dark Yellow): -7.2%
- 1'6" 600-700 kWh/m² (Light Yellow): -8.8%

**East Facade**
- 3' >900 kWh/m² (Red + Dark Red): -17.0%
- 1'6" >900 kWh/m² (Red + Dark Red): -9.8%

**Percent Reduction**
- Baseline (No Vertical Fins)
- Current Design
- Atelier Ten Recommended
Daylight Analysis & Fin Depth East Facade
Daylight Analysis & Fin Depth South Facade
Façade Optimization - Designing for Vegetation
Marina Bay - 2006
The Esplanade Theatres on the Bay

Michael Wilford + DP Architects
Design Criteria – Temperature, Humidity + Light

Flower Dome Conservatory

Light Levels
45,000 Lux for more hours than Eden

Air Temperature
Daytime condition: 25°C @ 65% RH max
Night-time condition: 17°C @ 65% RH or more
Ignition condition: 13°C @ 70% RH or more
Cool Dry Biome
Design Criteria

**Daylight Levels**
45,000Lux for more hours per annum than Eden

**Air Temperatures**
Daytime Condition – 25oC** @ 60% RH
Night-time Condition – 17oC @ 80% RH
Ignition Condition – 13oC @ 80% RH
Cool Dry Biome
Cool Moist Biome
Design Criteria

**Daylight Levels**
45,000 Lux for more hours than Eden

**Air Temperatures**
Daytime Condition – 25°C @ 80% RH +
Night-time Condition – 17°C @ 80% RH +
Ignition Condition – 16°C @ 80% RH +
Cool Moist Biome
The Biomes at Eden

Grimshaw 2000
Annual Global Luminance Levels for Plants
Greenhouse Conditions

Psychrometric Chart
Location: Singapore IWEC

Daylight Levels
45,000Lux for more hours per annum than Eden Project
Climate Analysis

Cloud Cover
Represented as annual percentage of sky vault visible at time

% of sky vault visible

Lux levels
Comparing spaces

Internal Illuminance Level (Lux)
Solar Control

Fully Deployed Shades
Maintain Internal Light Level below 45kLux
Reduce Solar Gain by Approx 90%.

Difference to internal solar gain approximately 80W/m² with full deployment of shading
Solar Control
Modeling Shading Impacts
Projected Illumination Levels and frequency for 65% VLT glass

Annual Hours Above Lux Level

Lux Level Exceeded (Thousands)

0 10 20 30 40 50 60 70 80 90 100

%

Eden
Gardens by the Bay

45,000 Lux

Shading Deployment
Glazing properties

Properties of high performance glass

Heat transmission

- Viraco
- Pilkington
- Saint-Gobain glass
- PPG
- ETFE
- Global projects

Solar reflective coatings
- Poor light transmissions

Body tinted glazing
- Equal light & heat transmissions

Advanced high performance
- Low emissivity
- High light, low heat

Traditional clear untreated glazing
- High light & heat transmissions

ALPINE HOUSE
- SINGLE Pane LOW IR

GARDENS BY THE BAY
- DOUBLE Pane LOW E
External Shading
External Shading
Solar Control

Internal Illuminance Level (Lux)

PERIODS WHEN SHADING IS DEPLOYED
Environmental Concept

- Return air duct integrated to facade
- Hot air purged to outside via openings in facade
- Active shading on exterior of facade. Options: 1- Tension blinds. 2- Movable opaque panels
- Cooled air + fabric cooling integrated to planting areas
- Air intake
- To energy centre / supertrees
- Plant rooms contain Supply & Extract AHU
- Air supply bulkheads
- Underfloor supply duct
- Fabric cooling
- Displacement grilles at regular intervals
- Motorised mounted impulse fans to ensure air velocity is 0.5 - 1 m/s

Cool / Dry Biome
Conditioning Strategy

1. Diffuser behind architectural finish
2. Supply air duct from plant rooms
3. Service runs combined into structure
4. Chilled floor to absorb some solar gain
5. Displacement air supply via vertical surface
The Cloud Forest

- **Diffuse Light 170w/m²**
- **Direct Light 876w/m²**
- **1,040w/m²**
- **374w/m²**
- **936w/m²**

1. Hot air purged to outside via openings in facade. Space is always positively pressurised
2. Active shading on exterior of facade. Self-furling shades
3. Air volume equivalent to fresh air rate purged through facade at high level
4. Return air duct integrated to mountain
5. Air distribution via ring ducts at each level to set diffusers pointing inwards and pointing outwards
6. No conditioning to walkways. Misters are on underside of walkway. Internal misters can be used to assist shade on very bright days
7. Misting nozzles distributed throughout surface of space
8. Air intake
9. Ground air handling plant room. Supply and extract AHU's dehumidification unit
10. Tunnel beneath building connecting air handling plant room plant room to core of mountain
11. Block box internal spaces conditioned with fan coil
12. Air distribution and fabric cooling integrated to planter and walkway areas
Gardens by the Bay, Singapore
Grant Associates and Wilkinson Eyre Architects
Biomass
The Energy Centre

Gardens By The Bay
Annual Carbon Evaluation

Annual Carbon Consumption Or Offset
[kg CO₂ / Year]

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<th>Power Consumption</th>
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<td>2,050 tons CO₂</td>
<td>1,770 tons CO₂</td>
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EXCESS
280 tons CO₂

Net CHP Power Generated

Total Cooling Power

- Desiccant Cooling Tower
- Desiccant Regen Fans
- Chilled Water Pumps
- Heat Rejection Pumps
- Electric Chiller