

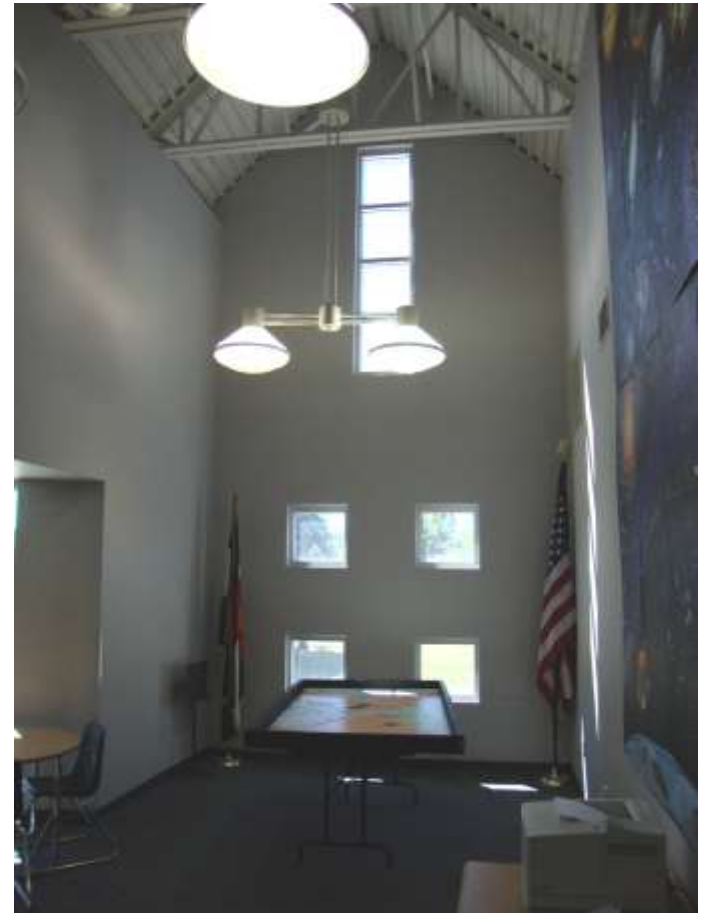
# Retro-fitting Daylighting in Existing Schools

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# Learning Objectives

- Understand failures of older daylighted schools and strategies for fixing them.
- Understand challenges of retrofitting daylighting into existing schools that were not daylighted.
- Understand failures in newer daylighted schools and how these may be corrected.
- Review examples and illustrations of all three scenarios above.



# Introduction

## Daylighting and Existing Schools

- The average school is 42 years old.
- Economics lead to fewer to new schools.
- More investment in renovation of existing schools.
- Better daylighting is needed in existing schools.



Gold Hill School – Gold Hill, CO  
• continuous operation since 1873

# Introduction

## Daylighting and Energy Use

- Electric lighting is typically 15-20% of school energy use.
- Daylighting saves energy by reducing use of electric lights.
- If electric lights stay on, energy use is more.
- Daylighting does not reduce air conditioning energy use.



Lights ON



Lights OFF

# Introduction

## Daylighting and Learning

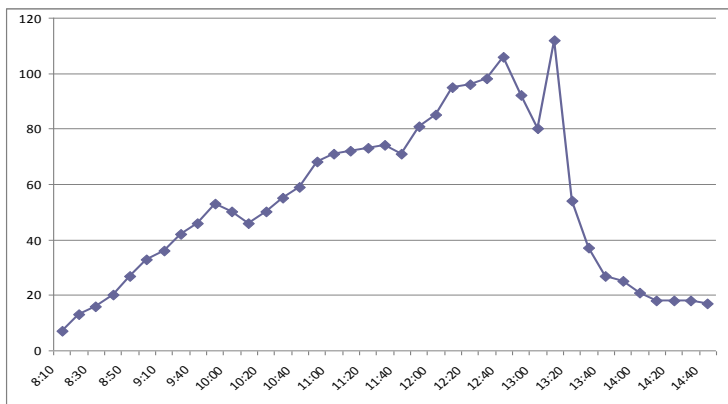
- Heschong Mahone Group 1999 study “Daylighting in Schools.”
- Heschong Mahone Group 2003 study “Windows and Classrooms.”
- 7% to 18% improvement in standardized test scores.



# Introduction

## Daylighting Mechanisms

- Full Spectrum, including 484 nm wavelength.
- Variability – day light levels vary.
- Brightness – daylit spaces tend to be brighter.
- View – windows provide views to the exterior.



Daylight Variability  
south facing, no electric light



# Introduction

## Evolutions of Daylighting in Schools

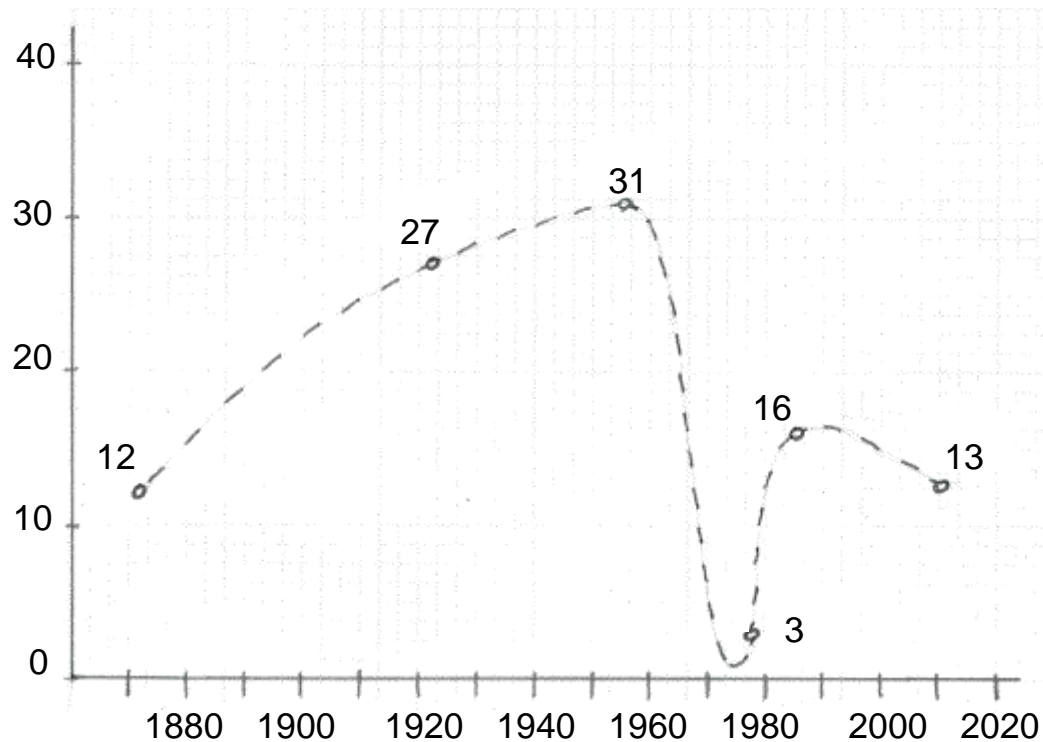
- Three Eras of School Lighting
  1. The Golden Age - Pre-Fluorescent lighting – up to 1960
  2. The Dark Age - Fluorescent lighting only – 1960-2000
  3. The Green Age - Re-emergence of Daylighting – 2000-present



# Introduction

## Evolutions of Daylighting in Schools

- Three Eras of School Lighting
  - The Golden Age - The Dark Age - The Green Age



# The Golden Age

## One Room Schoolhouse

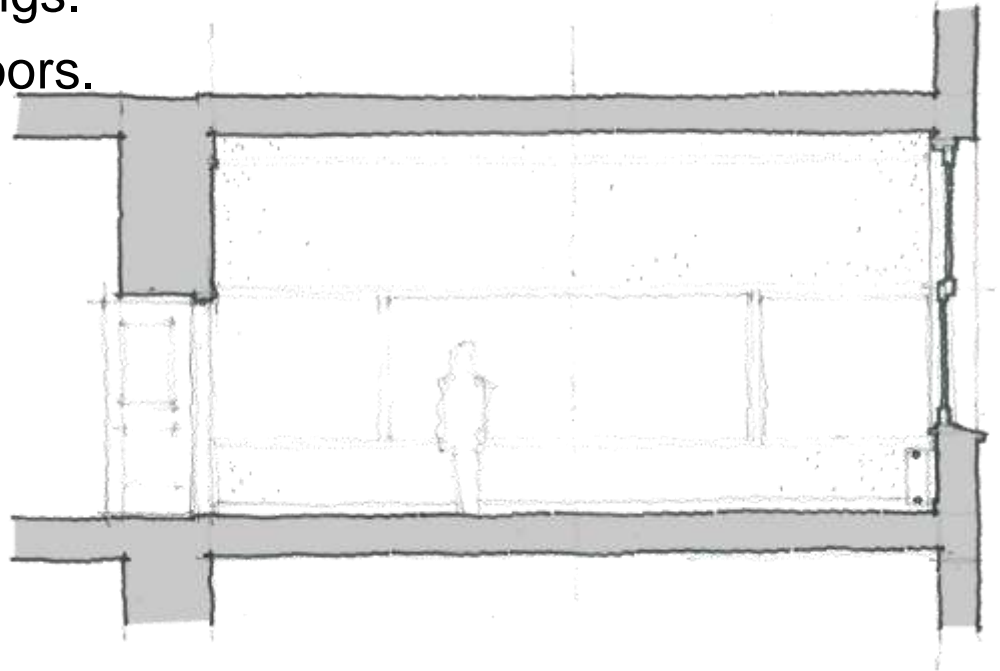
- High head height windows.
- Windows on both sides of classroom.
- Windows perpendicular to chalkboard.
- Bright upper walls and ceiling.



# The Golden Age

## 1924 – South High School

- Large wood double hung wood windows, paired (2-4 pairs / room).
- East / west exposures.
- Plaster walls and ceilings.
- Light colored maple floors.



# The Golden Age

## 1924 – Manny Martinez MS in West High School

- Interior remodeled in 2009
- Large wood double hung wood windows.
- Plaster walls and ceilings.
- Light colored maple floors.



Lights ON

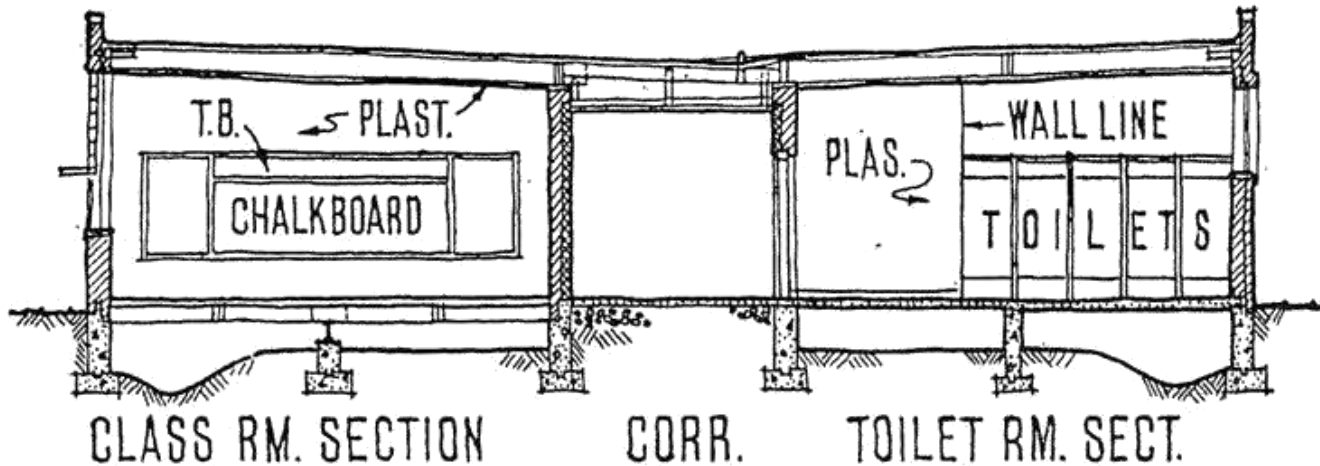
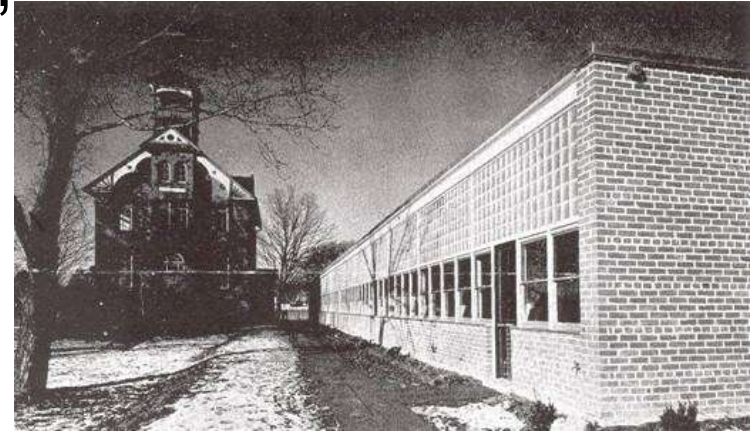


Lights OFF

# The Golden Age

## 50's "Splendor in the Glass"

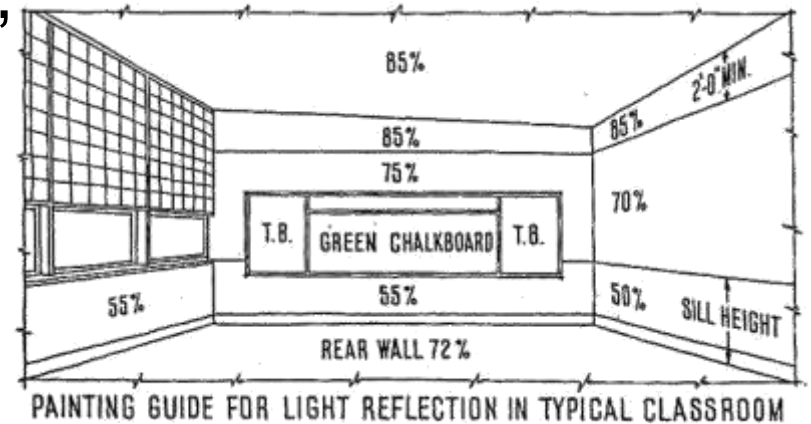
- Sloped ceilings.
- Translucent glazing.



# The Golden Age

## 50's "Splendor in the Glass"

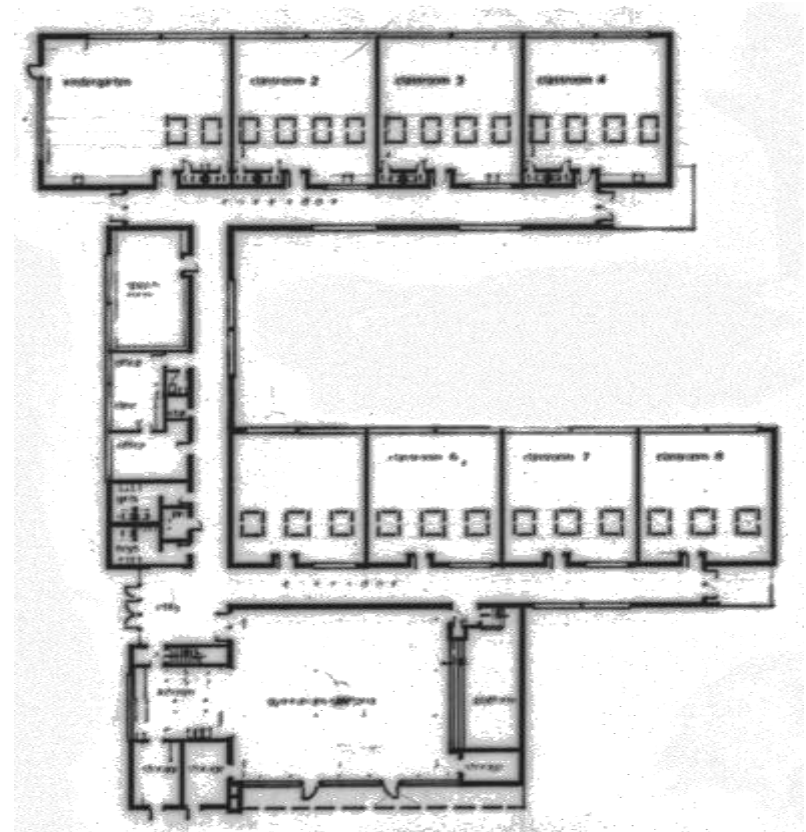
- Light interior finishes.



# The Golden Age

## 1950's – Jamaica Elementary School

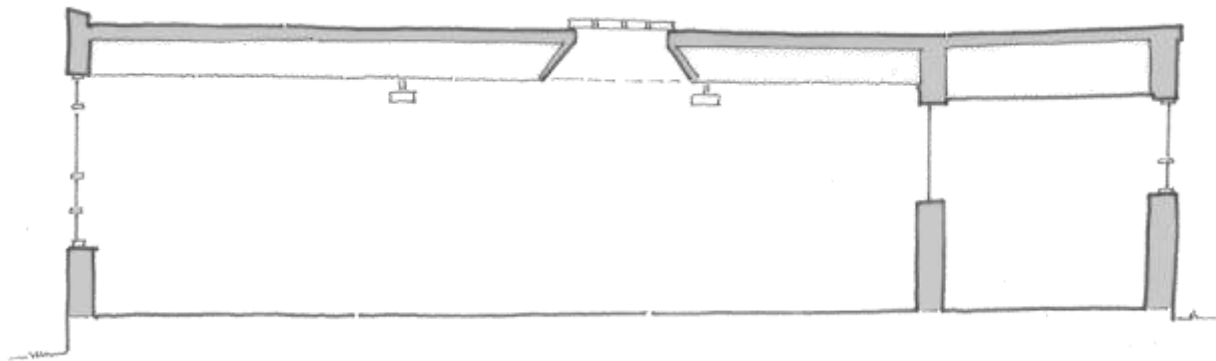
- Sloped ceilings.
- Single loaded corridors.
- Glass block skylights.
- North Windows.



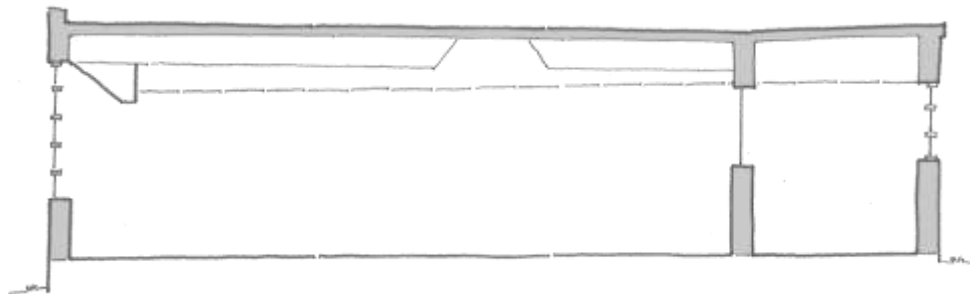
# The Golden Age

## 1950's – Jamaica Elementary School

- Glass block skylights.



Original daylight design



Retrofit with infilled skylight



# The Golden Age

1950's – Jamaica Elementary School

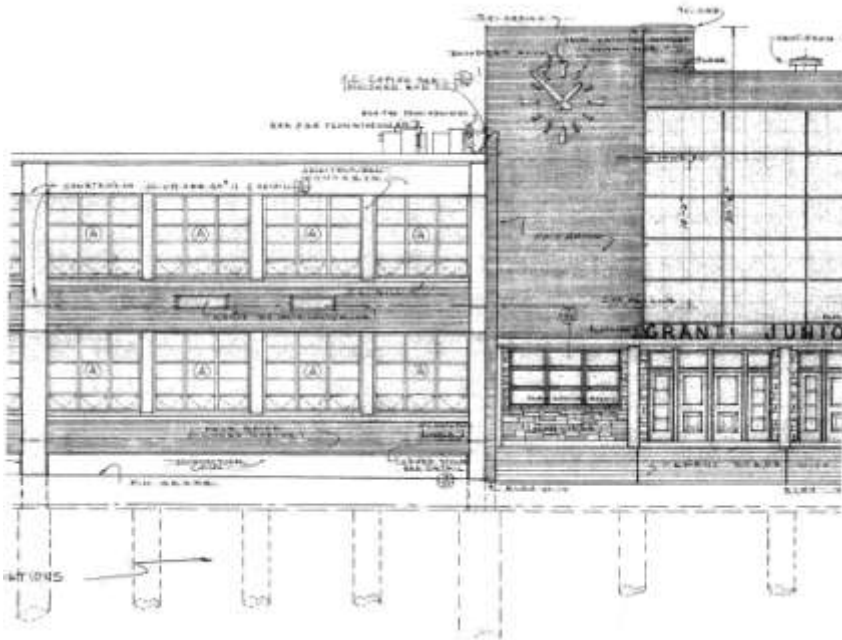
- Single loaded corridors.



# The Golden Age

## 1952 – Grant School

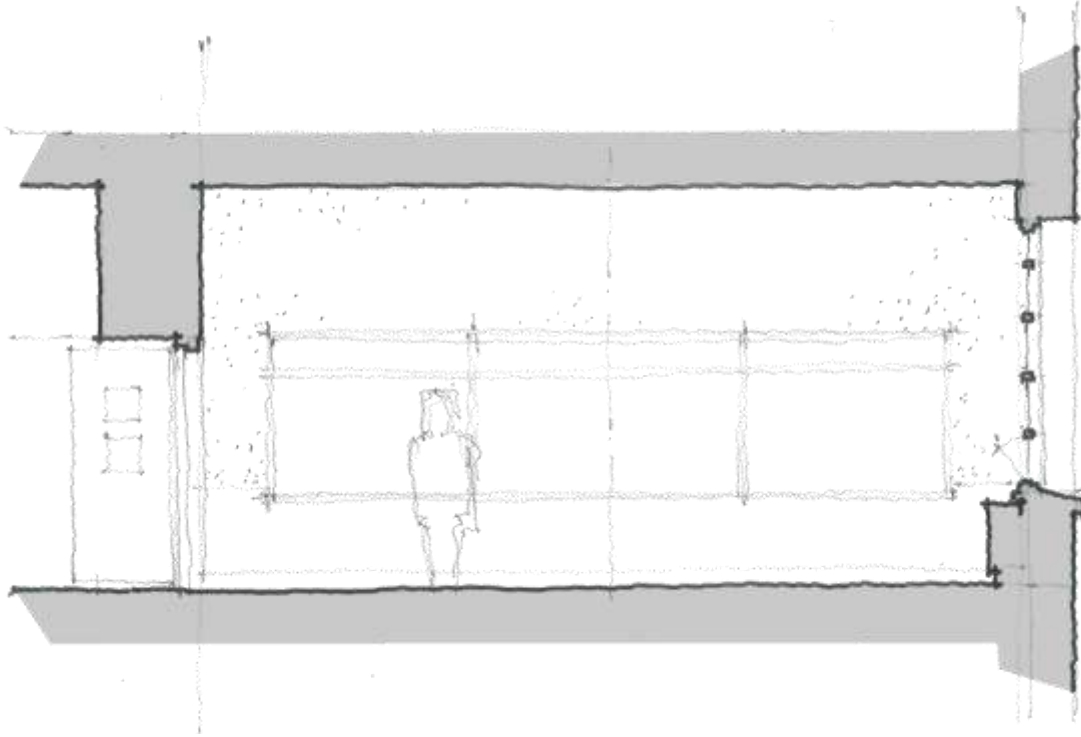
- East / west classroom exposure.
- Concrete frame with steel “window wall” infill.



# The Golden Age

## 1952 – Grant School

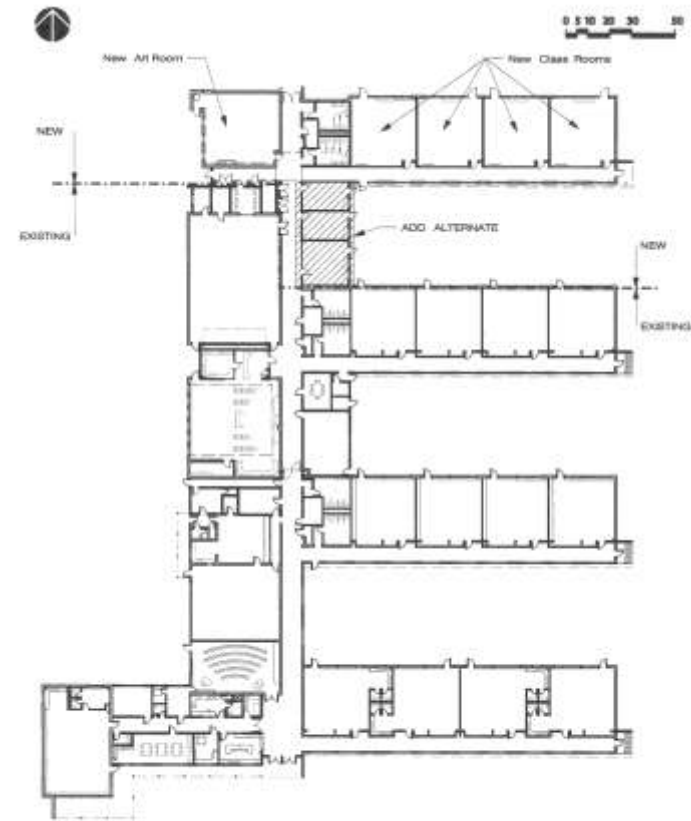
- White plaster walls.
- White acoustic ceiling.



# The Golden Age

## 1960's – Slater Elementary

- Single loaded corridors.
- High ceilings.
- South clerestories.
- North windows.

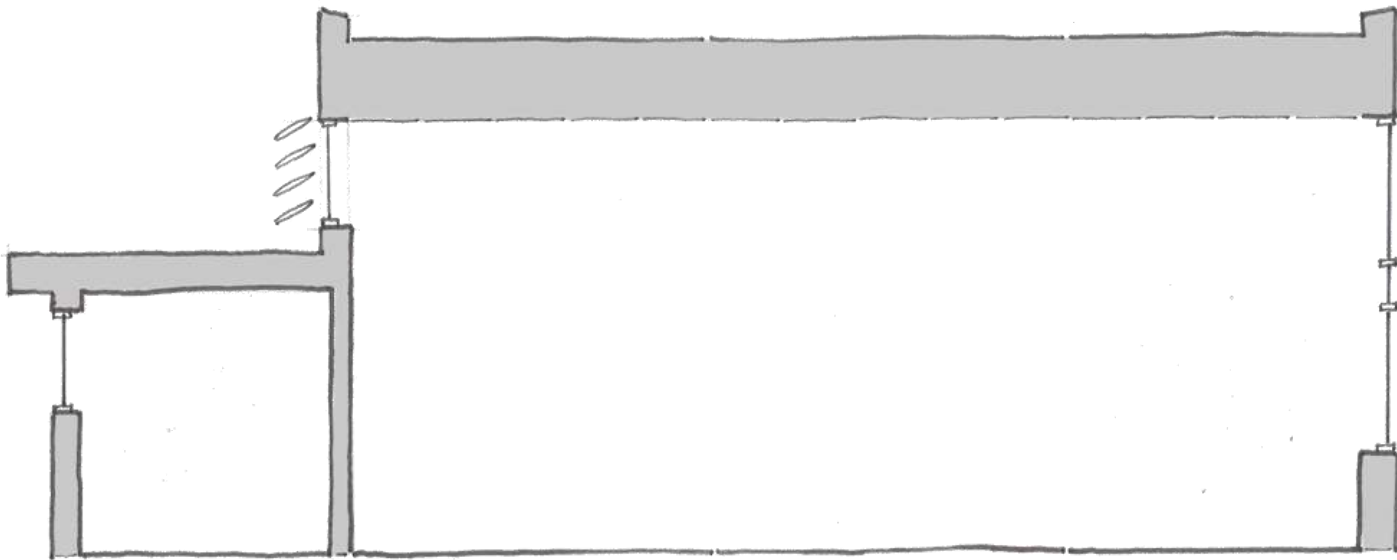


SLATER ELEMENTARY ADDITION RENOVATION  
JANUARY 7, 1994  
HUTTON FORD ARCHITECTS P. C.

# The Golden Age

## 1960's – Slater Elementary

- Single loaded corridors.
- High ceilings.
- South clerestories.
- North windows.



# The Golden Age

## Contemporary Peruvian School

- Daylit by necessity, no electric lighting.



# The Dark Age

## 1970's – Bergen Park Elementary

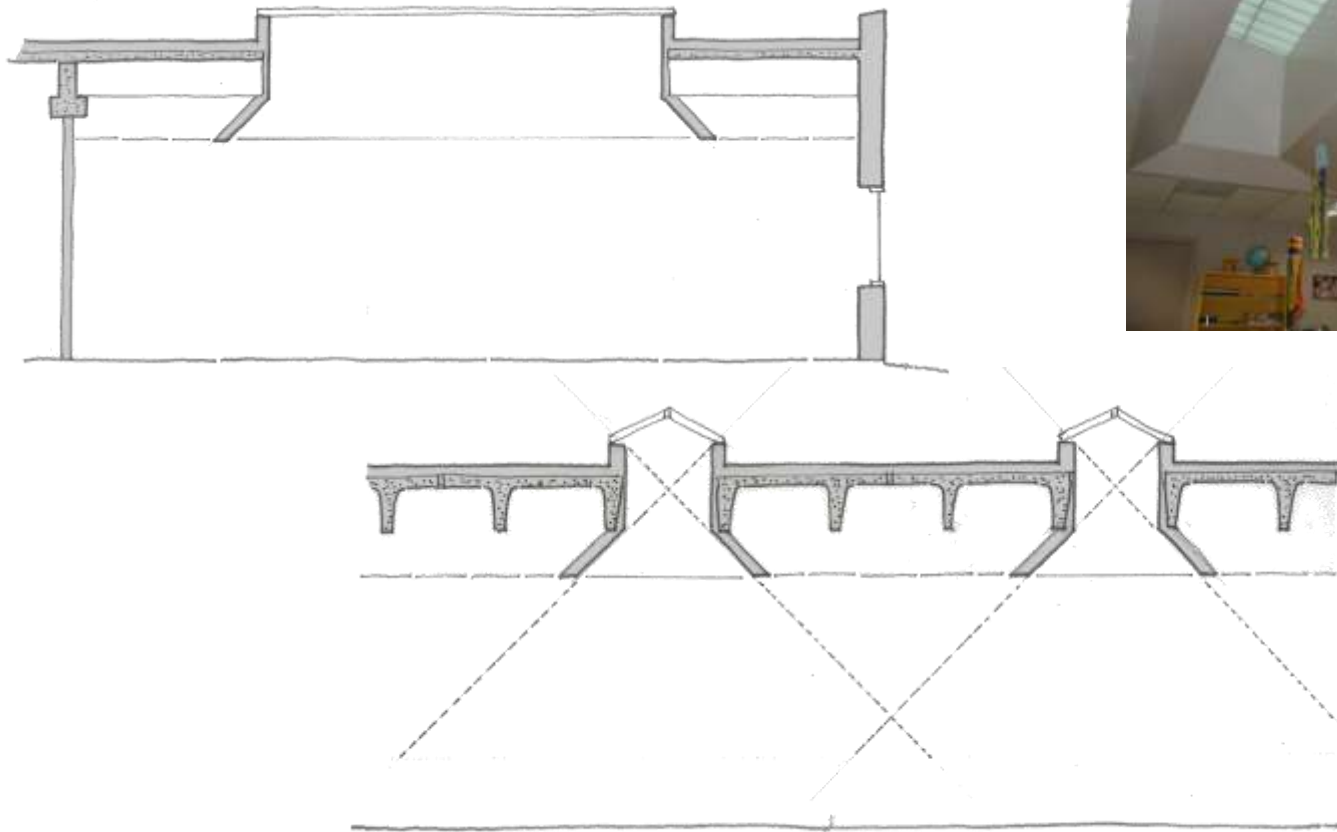
- Concrete exterior walls with few windows.
- Concrete twin tee roof.
- PA award winner in 1970.



# The Dark Age

1970's – Bergen Park Elementary

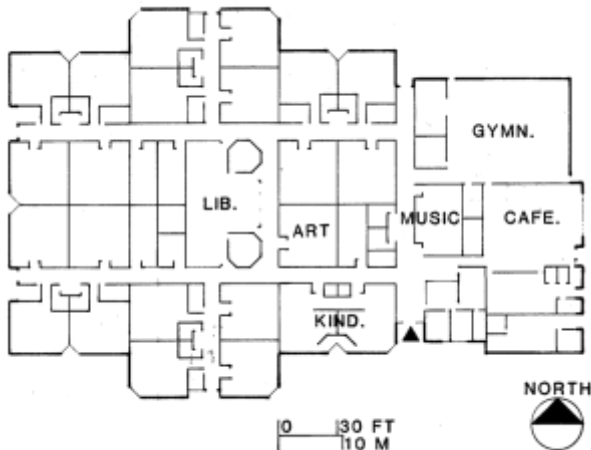
– Kalwall skylight.



# The Dark Age

## Dalton Elementary School – the Solar Machine

- Rooftop active solar space heating panels.
- Very high electricity use, low gas use.
- Minimal perimeter = Many interior classrooms.



# The Dark Age

## 1990's – Front Range Prototype Elementary

- “Sure they’re daylighted, every classroom has a window.”
- Skylights over lobby.
- Low window heads.
- No glass tuning.
- Several districts have built one or more of these.



# The Dark Age

## DeVinny Elementary School

- Low, flat ceilings.
- Minimal daylight penetration.
- Significant glare on desks.
- Retrofit with Kalwall outside of existing windows.



# The Green Age

## 1992-2010 – Dawson Middle School

- High clerestory with vertical blinds.
- Low view windows with tinted glass for glare control.
- Original dimming was V.E.'d out.



# The Green Age

## 1992-2010 – Dawson Middle School

- Clerestory windows replaced with suspended film fiberglass frame windows.
- Increased R-value.



# The Green Age

## 2005 – Challenge School

- Solid exterior sunshades block daylight.
- Sunshades do not extend far past window jambs.
- Sunshades are tight to wall.



# The Green Age

## 2005 – Challenge School

- Proposed solutions:
  - Wider, translucent sunshades.
  - Pull sunshades away from wall.

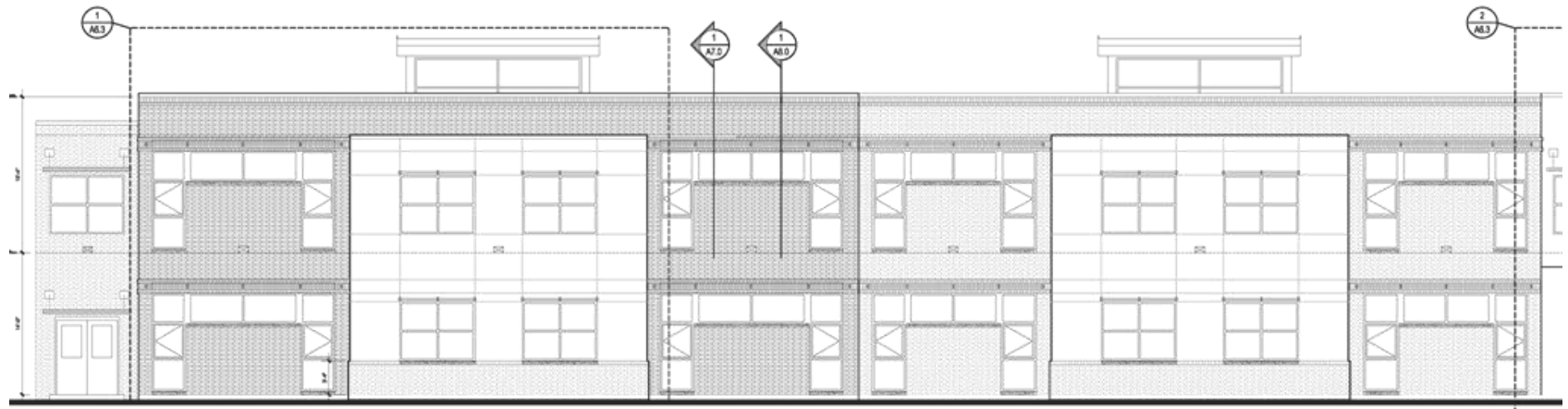
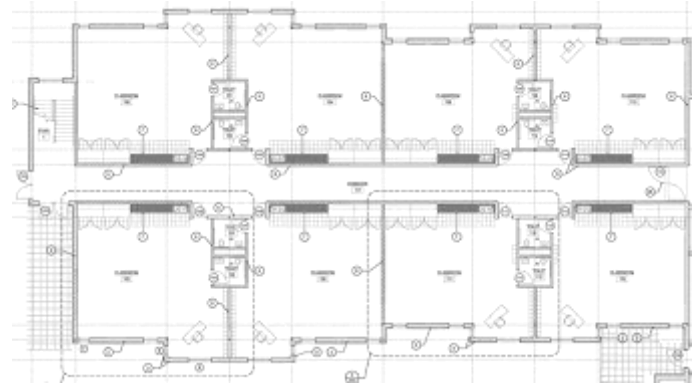


Douglas County Elementary School

# The Green Age

## Western Slope Elementary School Addition

- No toplighting for balance inside classroom.
- Sunshades are ineffective.
- Sunshades are poorly placed.
- Glazing is not tuned.



# The Green Age

## Academy Charter School

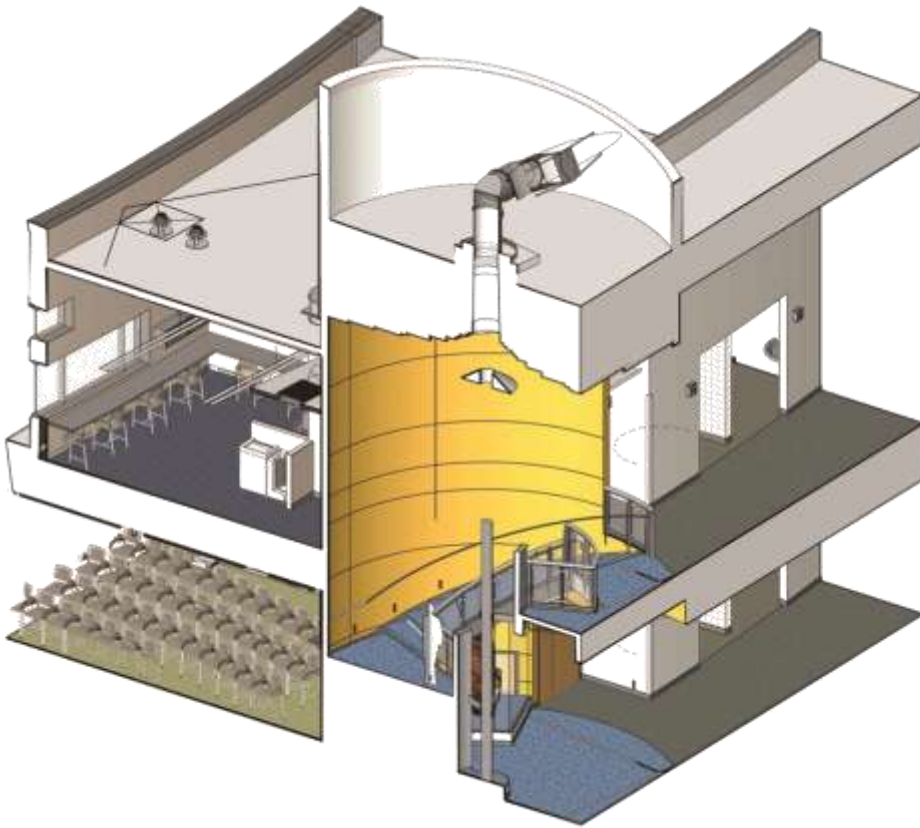
- Appropriate amount of glazing.
- Lack of glass tuning.
- Inadequate sunshades on south.
- Lack of protection for west windows.



# The Green Age

2011 – Institute of Science and Technology

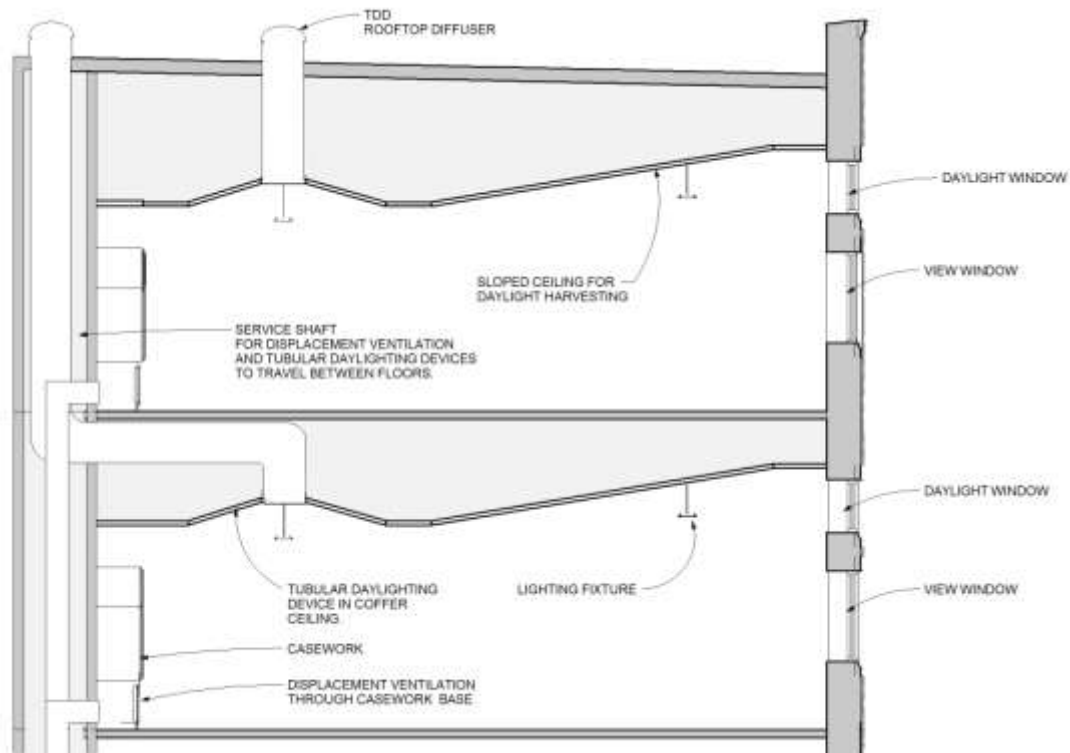
- Sundolier used to bring light deep into building.



# The Green Age

## 2011 – Institute of Science and Technology

- TDD's used to balance window/clerestory.
- TDD's used to illuminate ground floor of two story building.



# The Green Age

## Urban Schools – New York City

- Schools being inserted into mid-rise and high-rise buildings.
- No toplighting potential.
- Sidelighting may be limited by surrounding buildings.



# The Green Age

## Urban Schools – New York City

- Ineffective interior light shelf design.
- Lack of coordination with electric lighting design.



# The Green Age

## Urban Schools – New York City

- Maximize daylighting use at perimeter zone.
- Provide mechanism for preventing direct beam and glare.
- Provide daylight harvesting lighting controls.



# Retrofit Technologies

## Window Film

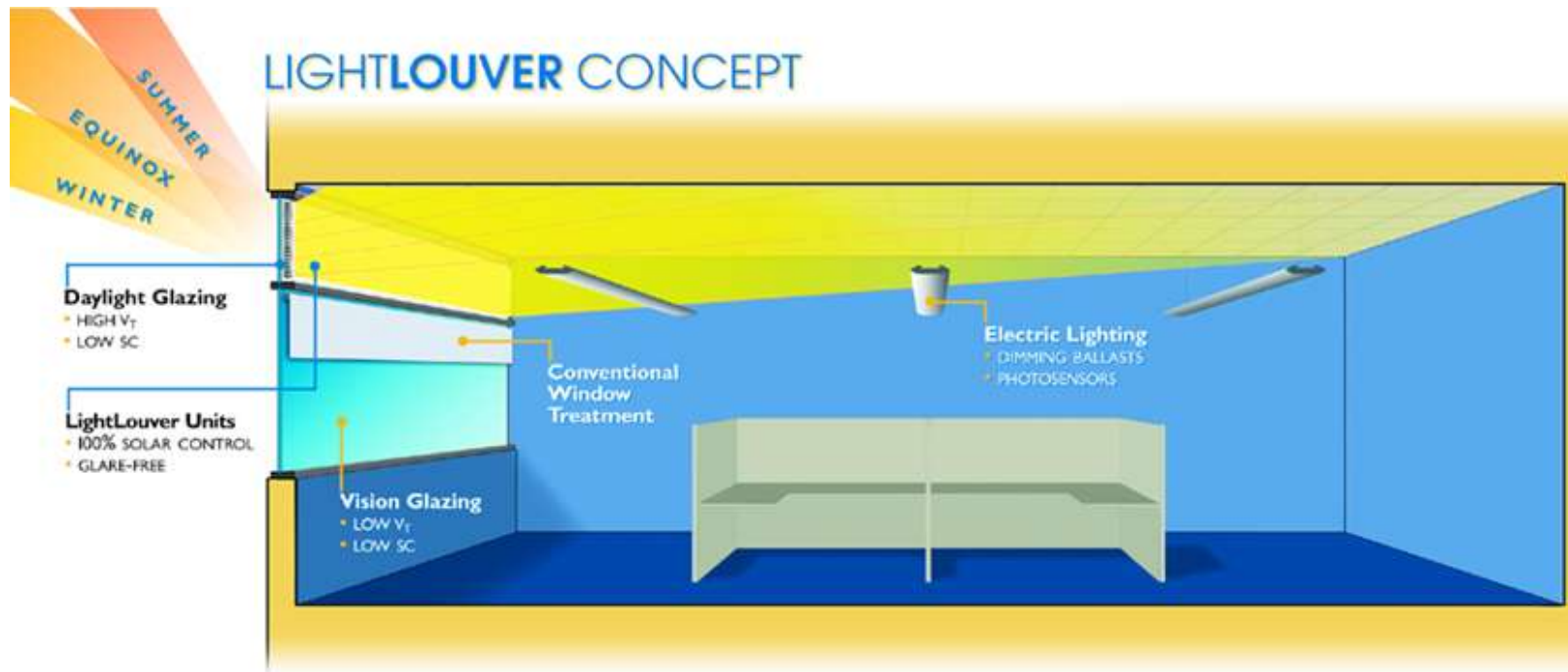
- Applied to existing single or double pane glazing.
- Reduces glare.
- Improves window performance without replacement.
- Reduces heat gain/increases comfort.
- Protects from UV.



# Retrofit Technologies

## Light Louver

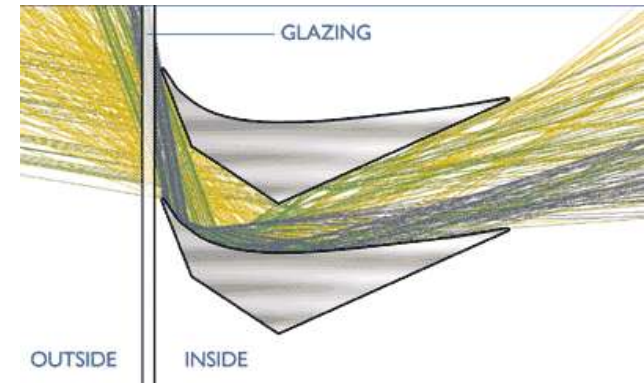
- Reflects light deep into space.
- Prevents clerestory light from becoming glare on work surface.



# Retrofit Technologies

## Light Louver

- Easy to retrofit, installs on inside face of existing glazing.



# Retrofit Technologies

## Electrochromic Glass

- Tvis may be reduced to 4%, in 5 minutes.
- No Tvis available between fully bright and fully dark.
- Functions as a Shade Cloth.
- Changes with less than 5 volts.



# Retrofit Technologies

## Sundolier

- Active daylighting, tracks sun across sky.
- Single 2 ft. dia. hole in roof.
- Illuminates up to 2,000 s.f.
- Can be ducted through multiple floors.



# Question and Answer

Retro-fitting Daylighting in Existing Schools

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