Washington Christian Academy

Flagship Building & Gymnasium

Penn State
Spring 2008

Casey Mowery AE Construction Management

Presentation Outline

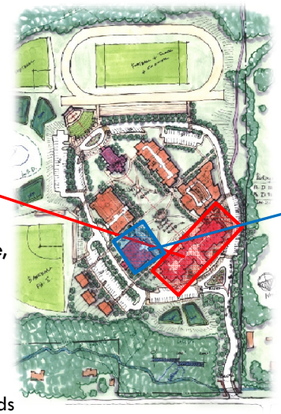
- Project Introduction
- Project Overview
- Analyses Introduction
- Analysis 1: Consequences of the English-Spanish Language Barrier in the Construction Industry
- Analysis 2: Incorporation of Daylighting in Classrooms
- Analysis 3: Redesign of Gymnasium Ductwork – Replace with Fabric Duct
- Conclusions
- Q & A

Project Introduction

Flagship Building

- School serves 300 K-12 students
- 3 stories; 67,600 SF
- Cost: 20.7 M (site & construction)

- Washington Christian Academy (WCA) phased construction project
- Location: 16227 Batchellors Forest Road, Olney, MD
- Campus to include:
  - elementary, middle, and high schools
  - performing arts spaces
  - athletic facilities
  - chapel
  - outdoor sports fields



- Construction Schedule: January 2007-August 2008
- Construction Manager: Forrester Construction
- Architect: Grimm+Parker Architects
- Owner: Washington Christian Academy

Gymnasium

- Separate building
- 1 story; 10,700 SF

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Priorities:

1. Schedule
2. Cost & Quality

Project Delivery Method:

Design-Build

Contract Types:

Single Prime Contract: Neg. GMP

↳ Subcontractors: Lump Sum

Project Overview

- Construction
  - Priorities
  - Project Delivery Method
  - Contract Types
- Structure
  - Envelope
  - Foundation
  - Superstructure
- Mechanical System
- Electrical System
- Emergency
- Local Conditions

Structure

- Envelope: Standard Cavity Wall with Built-Up Roof
- Foundation: Continuous Cast-in-Place Wall Footings with 5" SOG
- Superstructure: CMU Load Bearing Walls with Steel Joists

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Mechanical System
- 16 rooftop units; above average exhaust fans & condensing units for kitchen
- Supply: VAV fan powered terminal units, electric heat
- Ductwork: Insulated Sheet Metal

Electrical System
- Power connection on other side of Batchellors Forest Rd.
- Classroom lighting fluorescent recessed luminaires

Emergency System
- Annunciator panels & audio/visual smoke detectors
- Standard wet sprinkler system

WCA

Project Overview

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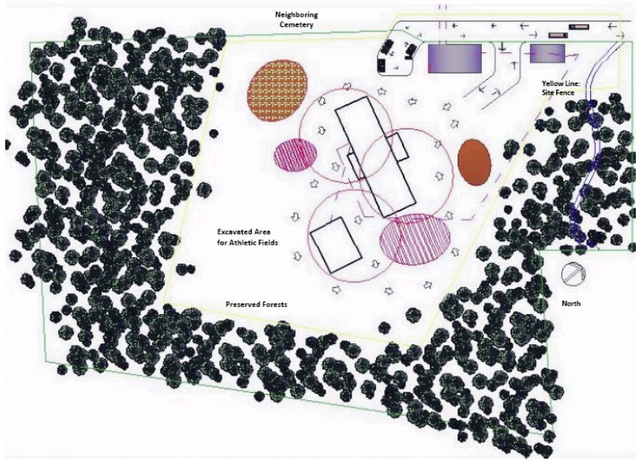

Analyses Introduction

Construction Management Critical Industry Research Issue

- English-Spanish language barrier in the construction industry today
- Inspired by the Partnership for Achieving Construction Excellence (PACE) Roundtable Event

Technical Analyses

- Owner priority: Add value
- Pennsylvania Governor's Green Government Council
  - Utilization of Natural Light
  - Improved Acoustics
  - Improved Indoor Air Quality

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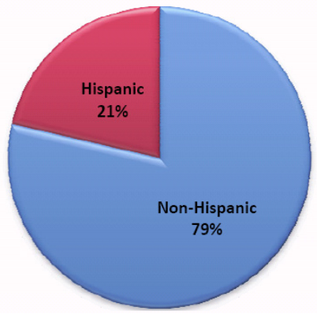
Research from the U.S. Census Bureau

Hispanic Workforce in the Construction Industry



Data from 2004
Construction second only to agriculture

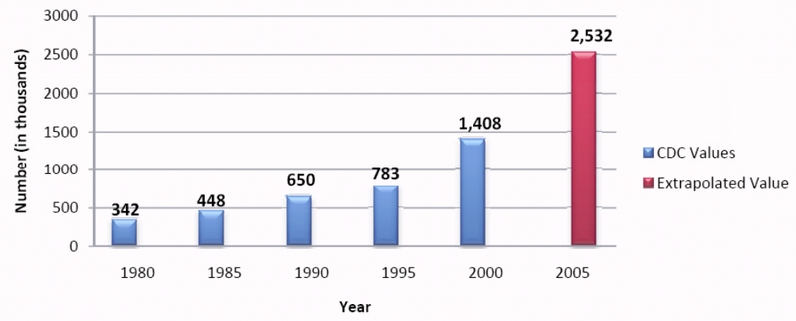
Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

- Problem
  - The English-Spanish language barrier between general contractors, subcontractors, and laborers in the construction industry creates problems with efficiency, safety, and a general level of respect.
- Goals
  - Determine status of barrier today according to research and industry member's opinions
  - Identify the five leading consequences the language barrier creates
  - Explore viable solutions to remedy the leading problems

Research from the U.S. Census Bureau

Number of Hispanic Employees in Construction, selected years 1980-2000



Hispanic influence on construction is growing fast

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Question Summary	Answer	Result (people)	Result (percent)
Does English-Spanish Language Barrier exist?	Yes	62	95.4%
	No	3	4.6%
Is it getting better or worse?	Better	21	35.0%
	Worse	39	65.0%
Are jobsite signs bi-lingual?	Yes	51	78.5%
	No	14	21.5%
Have you attempted to speak Spanish?	Yes	32	50.0%
	No	32	50.0%
Encounters with Spanish speaking industry members.	Never	2	3.1%
	Monthly	1	1.6%
	Weekly	6	9.4%
	Daily	55	85.9%

Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

- Survey Participants
  - Requirements
    - 3 years experience
    - currently working in the NE/Mid-Atlantic U.S.
    - result: 65 qualified response participants

Job Title	Number of Participants	Percentage of Participants	Average Years Worked in Construction Industry
Superintendent & Asst. Superintendent	16	24.6%	21
PM, Asst. PM, Executive, VP	32	49.2%	15
Field/Project Engineer	12	18.5%	4
Other: estimator, drywall foreman, structural engineer	5	7.7%	10

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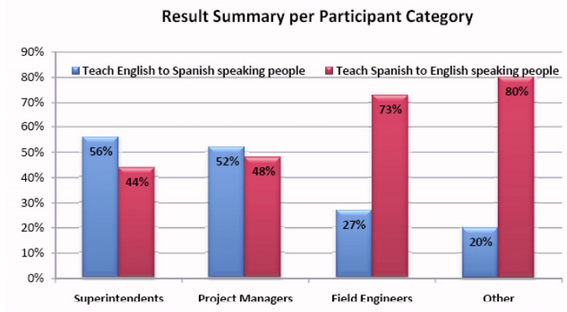
Which do you think is more likely to happen?

Answer	Total (all participants) Results (ppl.)	Results (%)	Per Participant Category Super (%)	Pvt (%)	P/P Eng. (%)	Other (%)
Teach English to Spanish speaking people	29	46%	56%	52%	27%	20%
Teach Spanish to English speaking people	34	54%	44%	48%	73%	80%



Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

Top 5 Consequences

1. **Difficulty in Giving Instructions**
2. **Greater Safety Risks**
3. **Loss of Productivity/Efficiency**
4. **Lack of Respect/Team Atmosphere**
5. **Other**

5. Discrimination

- Discrimination between English and Spanish workers is a real and damaging problem. Managers have encountered slurs on the job site.

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Teach English to Spanish Speaking Industry Members

Sed de Saber (Thirst for Knowledge)

WCA

Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

Solutions

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Teach Spanish to English Speaking Industry Members

Dozens of answers…

Construction Companies offer Spanish Classes & Manuals

Virginia Tech Building Construction Department

InterLingo

- Internet video conferencing with native speaking instructor from Columbia.
- Dual teaching strategy of group presentations and personal one-on-one review.
- 3 hrs/week for 6 weeks

Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

Conclusions

The English-Spanish language barrier does exist and it affects the progress and success of a project.

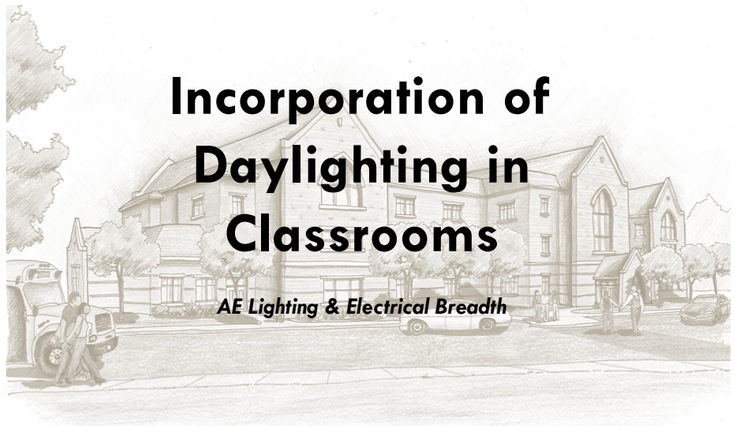
- 95% participants agree
- U.S. Census Bureau

My Opinion:

Regardless of what people would *like* to happen, teaching Spanish to English speaking people is the

- path of least resistance,
- most cost efficient, and
- most likely to succeed.

Company offered classes are not enough, management students should be taught in college when they are already in a learning-conducive environment.



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Analysis 2

Incorporation of Daylighting in Classrooms

- Problem

  The current classroom lighting is intended to be on all day, which is costly and reduces the benefits of the entering natural light.

- Goals
  - Determine if daylighting is possible when the row of lights nearest to the windows is turned off.
  - If inadequate, redesign space so that it is adequate.
  - Address energy and cost savings.

Advantages of Daylighting in Classrooms

- Energy Savings
- Improved productivity and health of students

Analysis 2

Incorporation of Daylighting in Classrooms

What is dayligthing?

The practice of using windows, skylights, or clerestories to allow penetration of natural light so that there are effective illumination levels in a given space.

How does it save energy?

- Reduced use of electrical lighting
- Daylight photosensors automatically dim or switch lamps off when an adequate level of illuminance is reached

Why is this a good idea for the WCA?

- Saves owner money from electrical savings
- Environmentally friendly
- Students can progress up to 20% faster than students in rooms with smaller window areas.

Daylighting Sensors

Daylighting Sensors

- Light level sensors that trigger certain lamps to turn off or dim when a preset illuminance level is met.

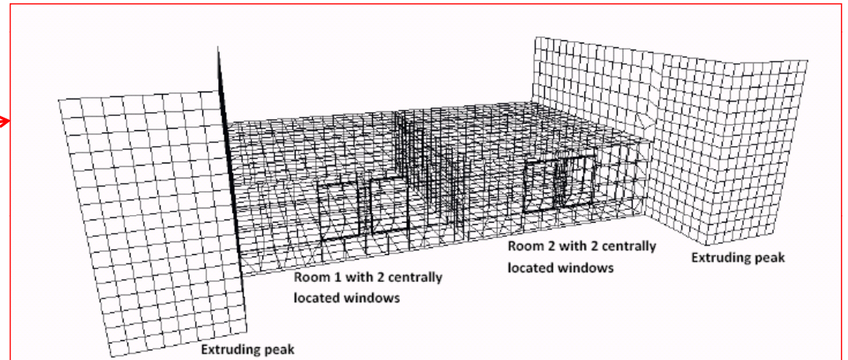
Switch or Dim?

Resources
- AutoCAD 2008
- AGi32

Calculations
- Daylight Factor
  - 2% in over 75% of the room area (LEED Rating)
- Illuminance
  - 50 footcandles for classroom +/- 10%

Analysis 2

Incorporation of Daylighting in Classrooms



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Analysis 2

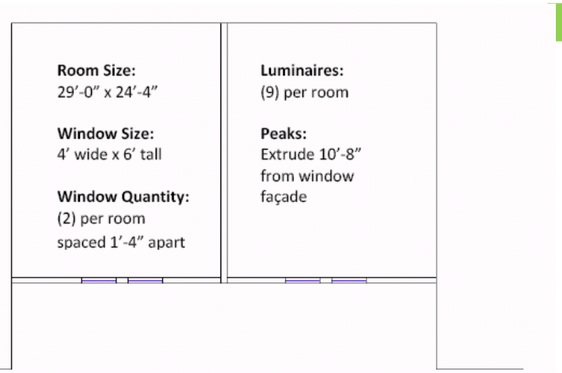
Incorporation of Daylighting in Classrooms

Current Room Design

New Room Design

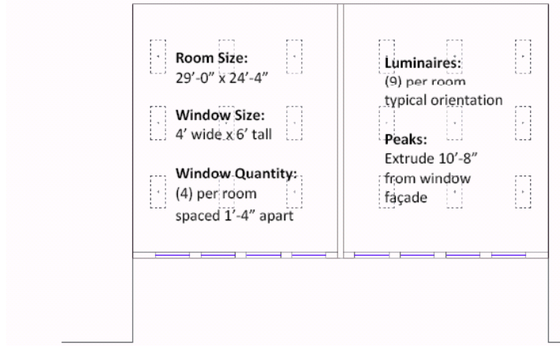
Lamp Quantity

1. 4 Lamps/Luminaire
2. 3 Lamps/Luminaire



Current Room Design

Calculate Illuminance & DF



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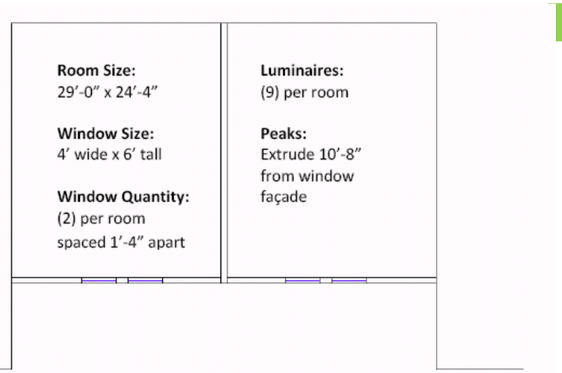

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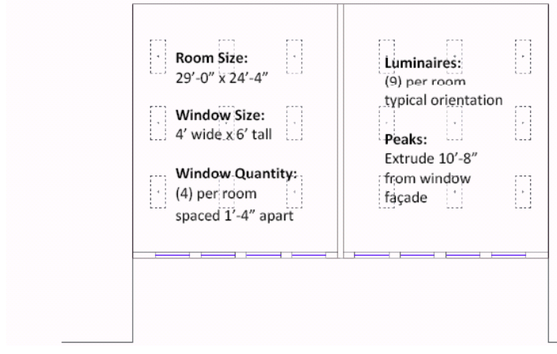

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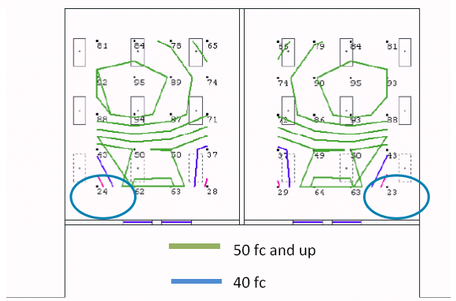
Illuminance Analysis

2 Rows ON
1 Row OFF



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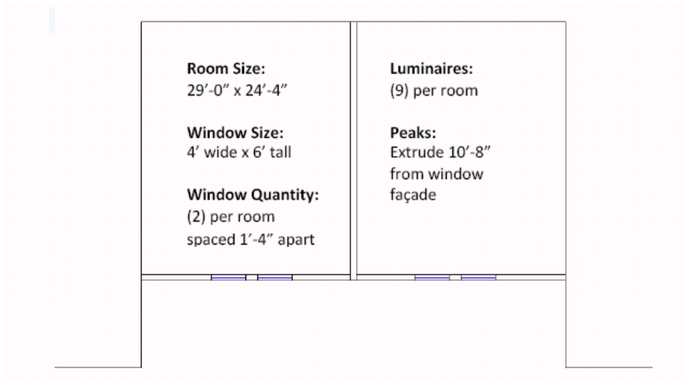

Current Room Design

Category	Trial	Description	No. Lamps	Lum. Orientation	Illuminance (E) Average (fc)	Max (fc)	Min (fc)
I	A	All Lights On (No Daylight)	4	typical	85.6	109.0	57.3
		All Lights Off (All Daylight)	4	typical	10.0	52.0	1.0
	C	Both Lights & Daylight	4	typical	95.9	123.0	69.0
		2 Rows Lights On, 1 Row Off	4	typical	67.9	95.0	23.0
	B	2 Rows Lights On, 1 Row Off	4	rotated 90°	68.9	93.0	23.0

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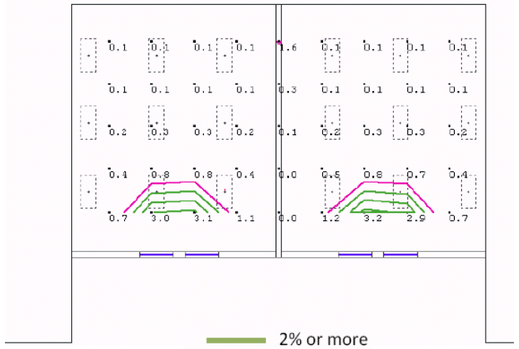
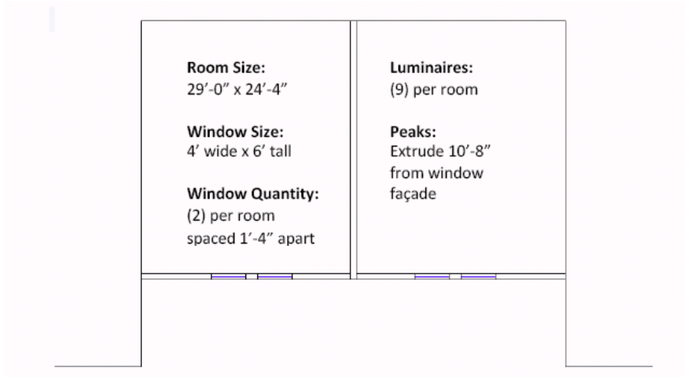
Daylight Factor Analysis



Analysis 2

Incorporation of Daylighting in Classrooms



Current Room Design

Categories	No. Windows	Daylight Factor (DF) Average	Max	Min	% area over 2% DF
I & II	2	0.7	8.3	0.0	10.6

Conclusion:

Current room design NOT acceptable for daylighting

- 2 windows do not provide enough light!

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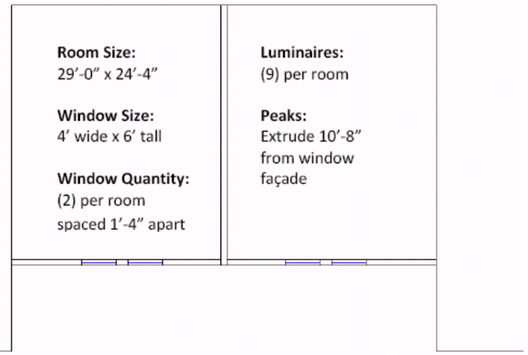


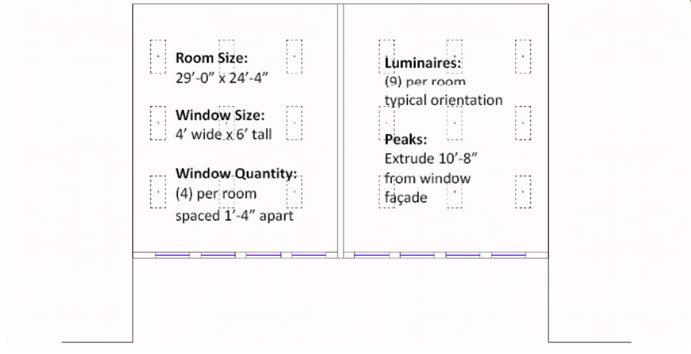
Current Room Design

New Room Design

Lamp Quantity

1. 4 Lamps/Luminaire
2. 3 Lamps/Luminaire

Calculate Illuminance & DF



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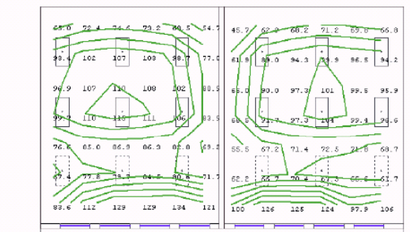
Illuminance Analysis

2 Rows ON
1 Row OFF



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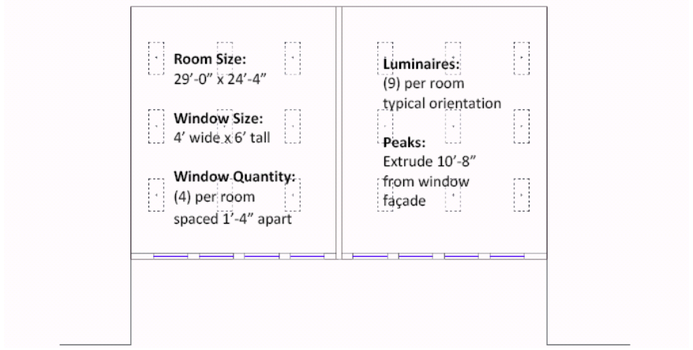

New Room Design with 4 Lamps

All Lights Off (All Daylight)	4	typical	10.0	52.0	1.0	

Category	Trial	Description	Lamps	Orientation	Avg (fc)	Max (fc)	Min (fc)
III	A	All Lights Off (All Daylight)	4	typical	39.3	126.0	12.2
	B	2 Rows Lights On, 1 Row Off	4	typical	92.0	134.0	54.7

2 Rows Lights On, 1 Row Off	4	typical	67.9	95.0	23.0

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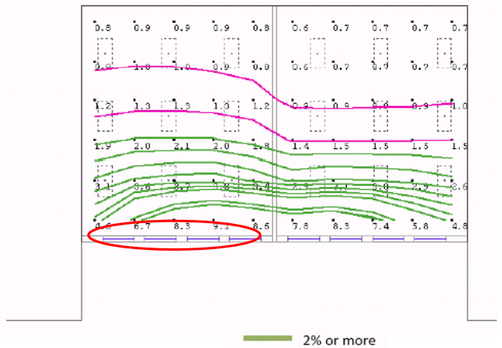
Daylight Factor Analysis



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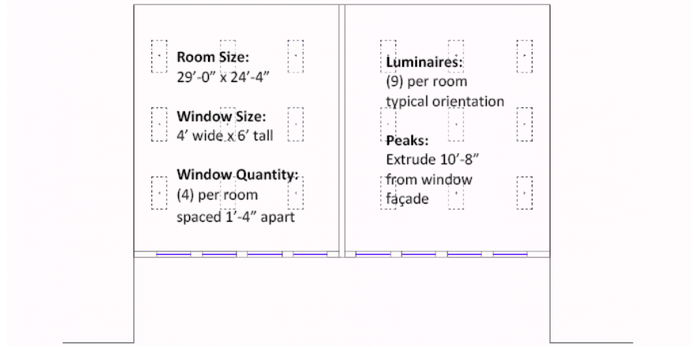

New Room Design with 4 Lamps

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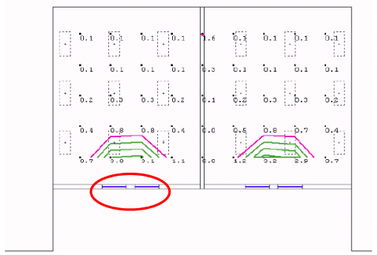
Categories	No. Windows	Daylight Factor (DF) Average	Max	Min	% area over 2% DF
III & IV	4	2.6	6.2	0.9	49.7
I & II	2	0.7	8.3	0.0	10.6



Conclusion:

- Daylight – OK!
- Illuminance – Very High

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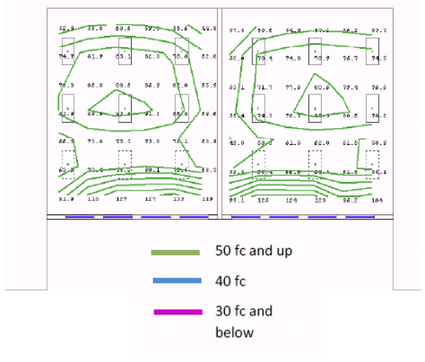

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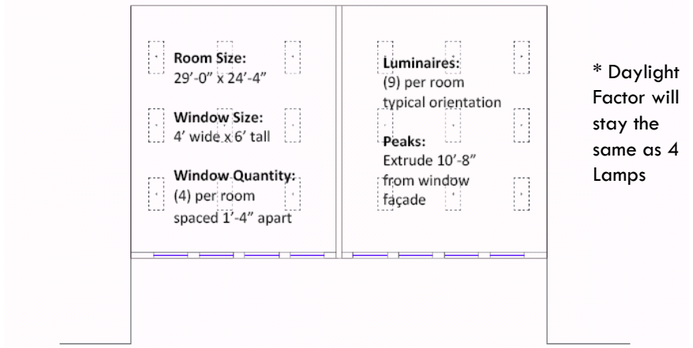
Incorporation of Daylighting in Classrooms



* Daylight Factor will stay the same as 4 Lamps

New Room Design with 3 Lamps

50 footcandles +/- 10%

Category	Trial	Description	No. Lamps	Lum. Orientation	Illuminance (E) Avg (fc)	Max (fc)	Min (fc)
IV	A	All Lights On (No Daylight)	3	typical	59.8	82.6	28.3
	B	Both Lights & Daylight	3	typical	99.0	163.0	46.5
	C	2 Rows Lights On, 1 Row Off	3	typical	79.9	133.0	44.8
	B	2 Rows Lights On, 1 Row Off	4	typical	92.0	134.0	54.7

Conclusion:

New Room Design with 4 Windows Acceptable for Daylighting

- 4 lamps provide very high level of illuminance, even with 1 row OFF
- 3 lamps provide adequate level of illuminance, within 10%

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Analysis 2

Incorporation of Daylighting in Classrooms

Analysis	Feature Descriptions	Daylighting Techniques	
		Acceptable	Not Acceptable
1. Current Room Design ***Trials I & II***	2 windows 4 lamps		✓
2. New Room Design ***Trial III***	4 windows 4 lamps	✓	
3. New Room Design & Lamp Change ★ ***Trial IV***	4 windows 3 lamps	✓	

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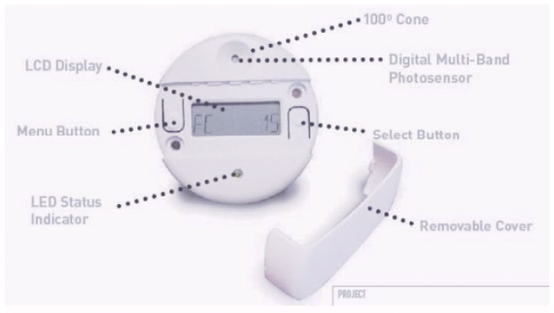
Daylight Sensor

	On/Off Switching	Dimming
Single Zone	LS-101 (either)	LS-301 (closed loop)
Multi Zone	LCD-203 system (open loop)	LCD-203 system (open loop)



Analysis 2

Incorporation of Daylighting in Classrooms

Cost

- Reduction of 4 lamps to 3 results in an automatic 25% electrical savings
- 1 row of lights off adds an additional 33% reduction
- Photosensors: $150 x 24 classrooms = $3600, expect 1 year to payoff
- No additional ballast cost
- No additional cooling costs expected due to Low-E and quantity of windows

Schedule

- Installing photosensors only addition
- Not long lead item
- Design phase feel greatest effects
  - Owner, Architect, & Electrical Engineer need to be incorporating from initial planning phase

Conclusions

- Current Room: Do Not Incorporate Daylighting
- If Redesign Possible: 4 Windows, 3 Lamps/Luminaire
  - Saves Energy & Money
  - Does Not Affect Schedule Completion
  - Better for Students
  - 3 Lamps Provides Switching Options
  - Educates Students on Benefits of Daylight

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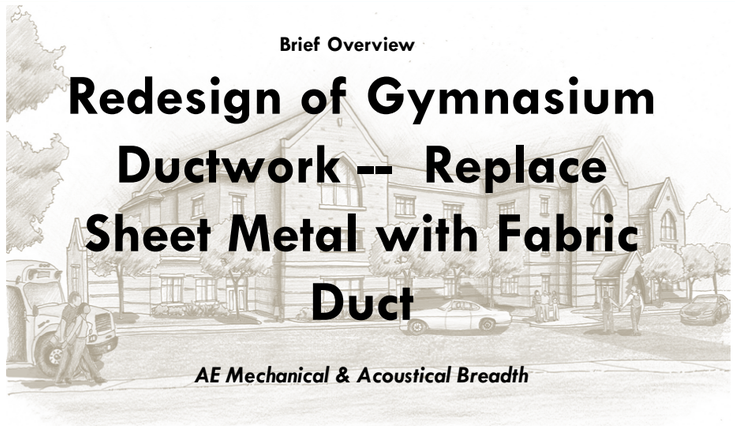
Analysis 3



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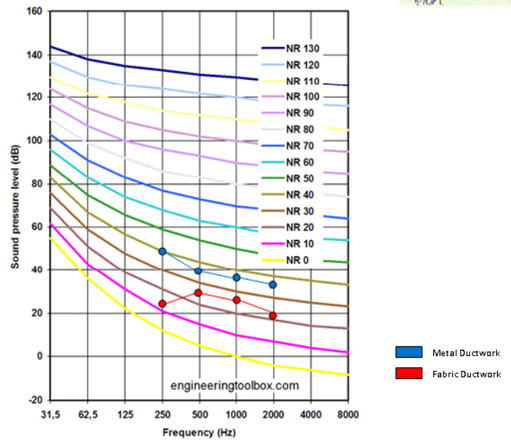
Analysis 3

Gymnasium Fabric Ductwork

- Result Summary
  - No structural redesign necessary
  - Fabric Duct provides
    - Smaller Noise Criterion, Less Reverberation Time, Greater Noise Reduction Coefficient
- Savings
  - 74% Cost Reduction
  - 84% Schedule Reduction

Owner	**Occupants**
Save Money	More Comfortable from Air Distribution
Finish Earlier	Better Acoustics
Maintenance Friendly System	Personalized Logos & Colors



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If Redesign were possible…

Incorporate Daylighting Practices in Classrooms

- Saves Energy & Owner Money
- Teaches students valuable lesson
- Improves students' educational performance
- No negative effects on schedule

Thesis Conclusions

The English-Spanish language barrier does exist in the construction industry, particularly in the Washington, D.C. market.

- Companies need to invest in educating their managers in Spanish.
- Universities need to invest in educating their students in Spanish.

Washington Christian Academy is seeking to build a high quality educational facility that promotes healthy and sustainable learning environments

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Replace Gymnasium Sheet Metal Duct with Fabric Duct

- 74% Cost Reduction
- 84% Schedule Reduction
- Improves:
  - Acoustics
  - Air Distribution
  - Maintenance
  - Customization
  - Installation

Acknowledgements

Thank you to the following for support and guidance throughout my senior thesis:

- Forrester Construction Company, especially
  - WCA Team
- Survey Participants
- Washington Christian Academy
- AE Faculty
- Fellow AE Students, especially
  - Nick Kutchi, Allen Walker, and Kristin Maruszewski

Any Questions?

Slides removed because of time constraints

Extra Slides

Analyses Introduction

Technical Analysis

- Incorporation of Daylighting in Classrooms
- Benefit students & reduce energy consumption, but only when lights are turned off

Construction Management Critical Industry Research Issue

- English-Spanish language barrier in the construction industry today
- Inspired by the Partnership for Achieving Construction Excellence (PACE) Roundtable Event

Technical Analyses

- Owner priority: Add value
- Pennsylvania Governor's Green Government Council
  - Utilization of Natural Light
  - Improved Acoustics
  - Improved Indoor Air Quality

Technical Analysis

- Redesign of Gymnasium Ductwork: Replace Sheet Metal with Fabric Duct
- Acoustical advantages will make the large space more comfortable for teaching activities

3rd Environmental Factor

- Not analyzed in detail
- Adding advanced filtration or installing CO_2 sensors

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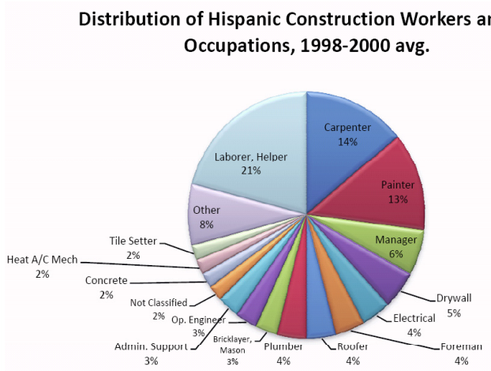
Research from the U.S. Census Bureau

Distribution of Hispanic Construction Workers among Occupations, 1998-2000 avg.



Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

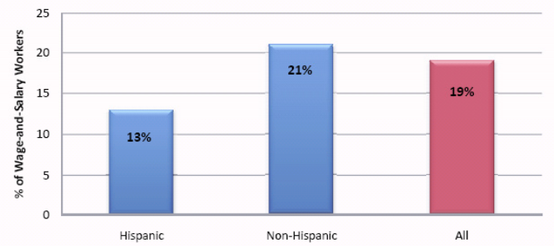
- Population Concentration:
  - 86% South & West
  - 8% Northeast
  - 6% Midwest
- 75% Mexican with 70% born outside the United States

Why does this matter?

- Spanish speaking immigrants
- Fatalities
- Unions

Research from the U.S. Census Bureau

Union Membership among Hispanic and Non-Hispanic Construction Workers, 2000



What this graph says about the survey…

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Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

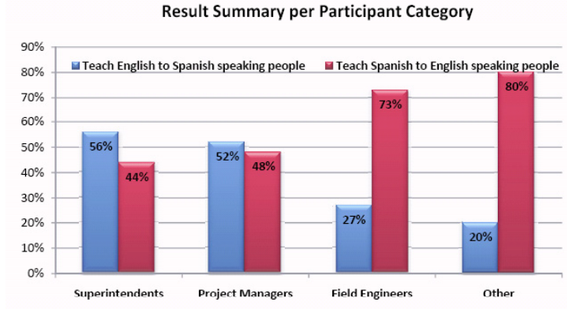
Participant Reasoning

Teach English to Spanish Speaking People	Teach Spanish to English Speaking People
❑ Helps Spanish speaking people personally and professionally. Gives workers a competitive advantage for promotions. ❑ With only one English speaking foreman on site who may speak broken English, you are relying too much on someone who may not understand you. ❑ English is part of the American culture.	❑ Many Spanish speaking workers are illiterate or uneducated so they are less able to learn. ❑ English is more difficult to learn. ❑ It is important and valuable to be bilingual. ❑ GCs and English speaking managers have greater resources and capabilities to learn Spanish; plus there are less of them.

Which do you think is more likely to happen?

Answer	Total (all participants) Results (ppl.)	Results (%)	Per Participant Category Super. (%)	PM (%)	F/P Eng. (%)	Other (%)
Teach English to Spanish speaking people	29	**46%**	56%	52%	27%	20%
Teach Spanish to English speaking people	34	**54%**	44%	48%	73%	80%

Result Summary per Participant Category



1. **Difficulty in Giving Instructions**
2. **Greater Safety Risks**
3. **Loss of Productivity/Efficiency**
4. **Lack of Respect/Team Atmosphere**
5. **Other**

1. Lack of safety culture in Spanish speaking supervisors.
2. Prejudice between Spanish speaking and Non-Spanish speaking employees.
3. Tougher to develop casual relationships from which to build long term relationships.
4. Foremen promoted on language, not skill.

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Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

Consequence	Total (all participants)	Super-intendents	Project Managers	Field Engineers	Other
Loss of Productivity/ Efficiency	22.4%	21.9%	22.6%	23.8%	19.5%
Greater Safety Risks	27.3%	29.1%	26.1%	27.5%	27.6%
Difficulty in Giving Instructions (Basic Jobsite Communication)	30.0%	29.8%	30.3%	30.3%	27.6%
Lack of Respect/ Diminished Team Atmosphere	17.9%	18.2%	16.7%	17.4%	25.3%
Other (Write In)	2.4%	1.0%	4.3%	1.0%	0.0%
1st 2nd 3rd 4th 5th	Color Key				

5. Discrimination

- Discrimination between English and Spanish workers is a real and damaging problems. Managers have encountered slurs on the job site.
- Discrimination exists even within each language.
- Seems as though the two parties are competing to occupy the site; English speaking workers feel more entitled.

Top 2 Consequences:

- Difficulty in Giving Instructions
- Increased Safety Risks

These consequences are serious and need to be remedied

Industry divided over teaching

- English → Spanish or
- Spanish → English

Analysis 1

Consequences of the English-Spanish Language Barrier in the Construction Industry

Conclusions

The English-Spanish language barrier does exist and it affects the progress and success of a project.

- 95% participants agree
- U.S. Census Bureau

My Opinion:

Regardless of what people would *like* to happen, teaching Spanish to English speaking people is the

- path of least resistance,
- most cost efficient, and
- most likely to succeed.

Company offered classes are not enough, management students should be taught in college when they are already in a learning-conducive environment.

Daylighting Sensors

- Light level sensors that trigger certain lamps to turn off or dim when a preset illuminance level is met.

Switch or Dim?

WA

Analysis 2

Incorporation of Daylighting in Classrooms

Daylighting and Occupancy Sensors

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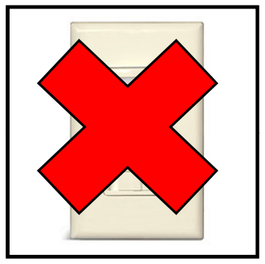
Occupancy Sensors

- Detect when a space is occupied using infrared technology.
- Great idea….right?



Please Don't Forget to Turn Out the Lights!

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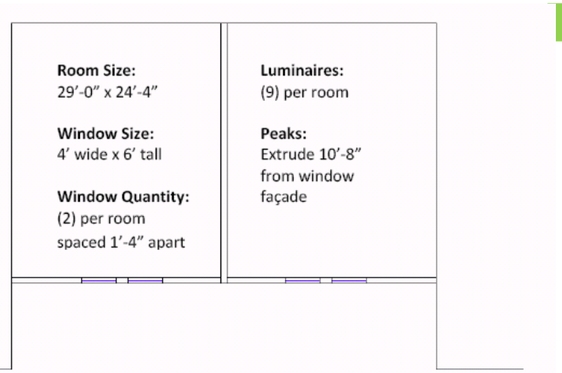
Analysis 2

Incorporation of Daylighting in Classrooms

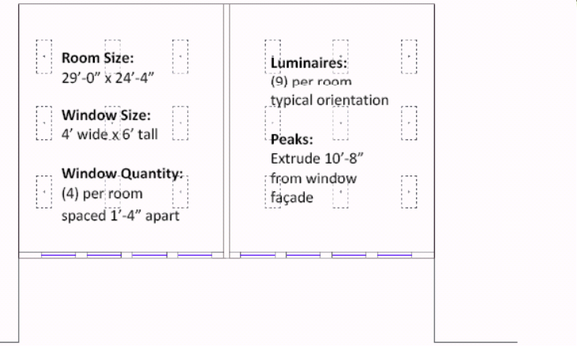
Current Room Design New Room Design

Luminaire Orientation Lamp Quantity

1. Current 1. 4 Lamps/Luminaire
2. Rotated 90 degrees 2. 3 Lamps/Luminaire



Current Room Design



New Room Design

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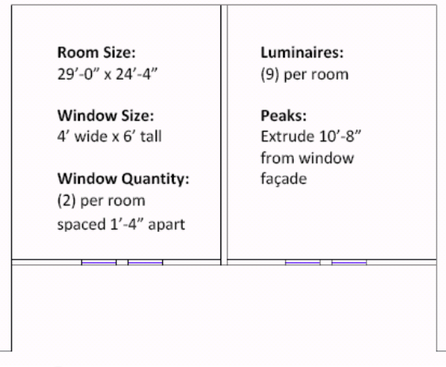
Analysis 2

Incorporation of Daylighting in Classrooms



Current Room Design

New Room Design

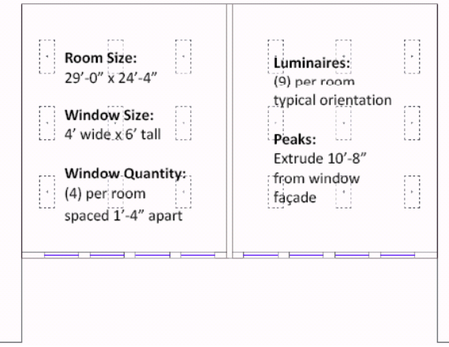
Lamp Quantity

1. 4 Lamps/Luminaire
2. 3 Lamps/Luminaire

Current Room Design

Luminaire Orientation

1. Current
2. Rotated 90 degrees



New Room Design

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Luminaire Orientation

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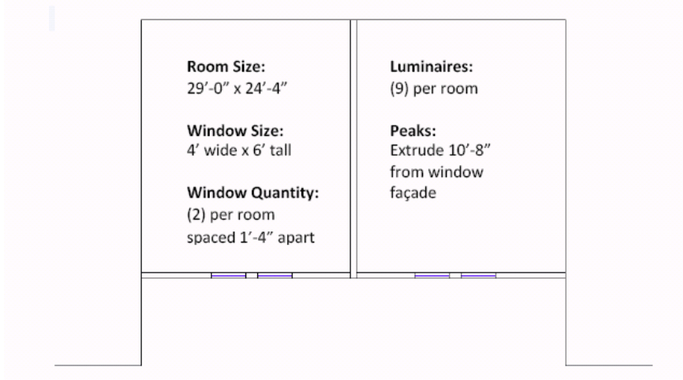
Analysis 2

Incorporation of Daylighting in Classrooms



Current Room Design

Category	Trial	Description	No. Lamps	Lum. Orientation	Illuminance (E) Average (fc)	Max (fc)	Min (fc)
I		All Lights On (No Daylight)	4	typical	85.6	109.0	57.3
	B	Daylight)	4	typical	10.0	52.0	1.0
	C	Both Lights & Daylight	4	typical	95.9	123.0	69.0
	D	2 Rows Lights On, 1 Row Off	4	typical	67.9	95.0	23.0
II		All Lights On (No Daylight)	4	rotated 90°	87.2	103.0	66.0

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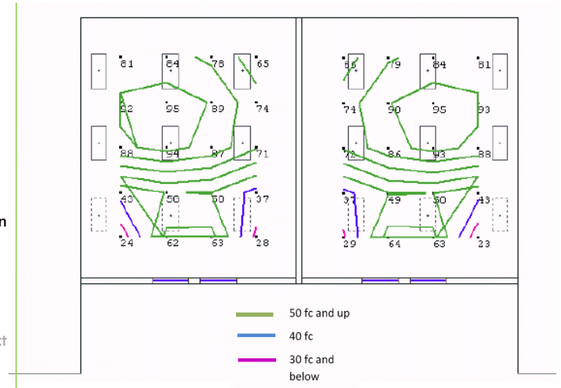
Analysis 2

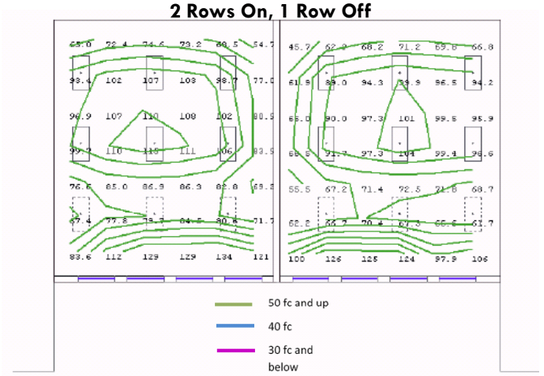
Incorporation of Daylighting in Classrooms

Current Room Design: 2 Windows
2 Rows On, 1 Row Off

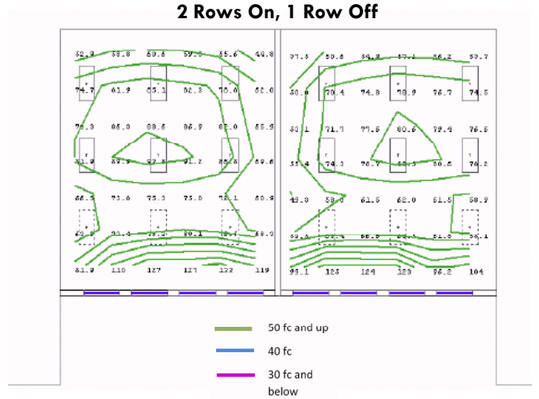


Illuminance

New Room Design: 4 Windows, 4 Lamps
2 Rows On, 1 Row Off



New Room Design: 4 Windows, 3 Lamps
2 Rows On, 1 Row Off



Illuminance

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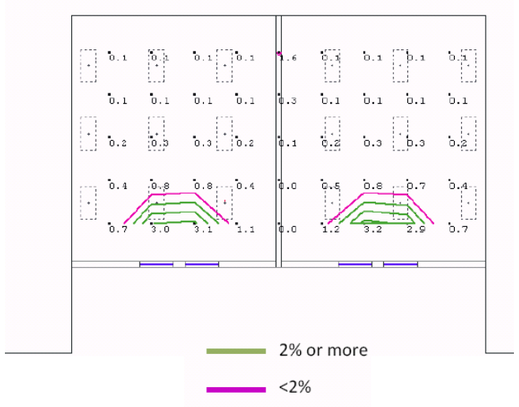
Analysis 2

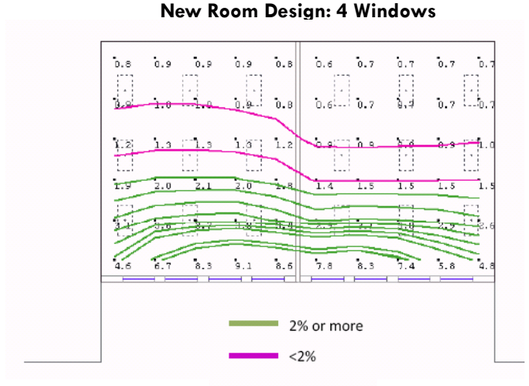
Incorporation of Daylighting in Classrooms

Current Room Design: 2 Windows



Daylight Factor

New Room Design: 4 Windows



Hypothesis Attempted	Daylighting Capabilities	
	Improve	Not Improve
Rotate Luminaires 90°		✓
Increase to 4 windows/room	✓	
Decrease to 3 lamps/luminaire	✓	

Analysis	Feature Descriptions	Daylighting Techniques	
		Acceptable	Not Acceptable
1. Current Room Design ***Trials I & II***	2 windows 4 lamps		✓
2. New Room Design ***Trial III***	4 windows 4 lamps	✓	
3. New Room Design & Lamp Change ***Trial IV***	4 windows 3 lamps	✓	

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Advantage Comparisons

	Fabric Ductwork	Sheet Metal Ductwork
Acoustics	• Better • Reduces resonance	• Worse • Turns create turbulence
Air Distribution	• More uniform	• Concentrated near diffusers
Installation	• 90% faster that Sheet Metal[13]	• Much more intensive (hrs, crew)
Weight	• 1 psf[14]	• 40 psf[14]
Environmental Factors	• Resists scratches, dents common from volleyballs, basketballs, etc.	• Easily scratched or dented during installation, common physical activities
Condensation/Dust	• Porous fabric allows air flow through material • Prevents condensation/dust accumulation on exterior surface	• Metal allows air flow only through specified outlets • Condensation/dust accumulate on exterior surface
Color	• Optional colored fabric matches walls/ceilings • Silk screening allows for team names, logos on ductwork	• Optional painted exterior surface • Likely to scratch & need touch-ups
Maintenance	• Vacuum or machine washable • Easily removed and re-hung • No lifting machinery needed	• Expensive • Usually requires 3rd party • Lifting machinery needed

WCA

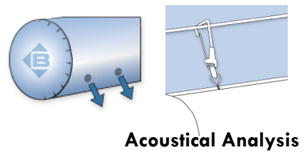
Analysis 3

Gymnasium Fabric Ductwork

- Problem
  - Current ductwork in the gymnasium is insulated sheet metal
  - Creates a noisy environment which is not cohesive for a learning/coaching environment
- Goals
  - Replace sheet metal ductwork with fabric ductwork
  - Perform acoustical analysis of space with new fabric duct
  - Address cost and schedule impacts
  - Determine if the change is worthwhile for the WCA

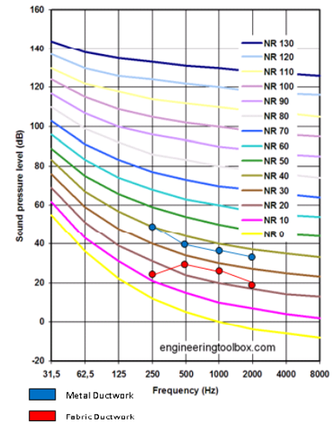
Fabric Ductwork Redesign

- **7 Design Steps**
- **Determined: Application, Fabric Type, Color, Size, Airflow Pattern, Suspension, & Filtration**
- **No Structural Redesign Necessary**



Acoustical Analysis

- **Noise Criterion (NC)**
  - **Sheet Metal Avg: NC-40**
  - **Coated Polyester Fabric Avg: NC-25**
- **Reverberation Time**
  - **Fabric 7% reduction (0.22 seconds)**
- **Noise Reduction Coefficient (NRC)**
  - **Sheet Metal: 0.00-0.05**
  - **Coated Polyester Fabric: 0.20**



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Cost Comparison

Construction

Ductwork	Material Cost	Labor Cost	Total Cost
Metal	$1,800	$5,850	$7,650
Fabric	$1,190	$2,010	$3,200
Difference	$610 saved	$3,840 saved	**$4,450 saved**

Shipping

Ductwork	Weight (lbs.)	Shipping Cost[17]
Metal	7,360	$5,360
Fabric	230	$160
	Difference	**$5,200 saved**

Total Metal Ductwork: $13,010

Total Fabric Ductwork: $3,360

Savings: $9,650

74% Cost Reduction

5% Mechanical Savings

WA

Analysis 3

Gymnasium Fabric Ductwork

Conclusions

- Highly recommend replacing gymnasium ductwork with fabric.
- Fabric system improves every mechanical aspect of the gymnasium.

Owner
Save Money
Finish Earlier
Maintenance Friendly System

Occupants
More Comfortable from Air Distribution
Better Acoustics
Personalized Logos & Colors

Schedule Comparison

- **Original schedule calls for 25 days installation**
- **Fabric Duct: 3 man crew can install 50 LF per day**
- **New schedule results in 4 days**
- **Saves 21 days – 84% Reduction**