SOUTHERN
MANAGEMENT CORPORATION

CAMPUS CENTER

Josh Winemiller

AE Senior Thesis Presentation

Dr. Richard Mistrick and Prof. Ted Dannerth | April 13, 2011 | Lighting/Electrical

THESIS SCOPE OF WORK

- Lighting Depth
  - Exterior Space | North Façade
  - Circulation Space | Main Lobby
  - Large Work Space | Classroom
  - Special Purpose Space | Natatorium
- Electrical Branch Circuit Redesign
- Electrical Depth
  - Wire/Conduit vs. MC Cable Feeders
  - SKM Power Tools Analysis
- MAE Focus
  - Daylighting - Natatorium
- Breadth Topics
  - Mechanical – SHW Natatorium
  - Structural – SHW on Roof

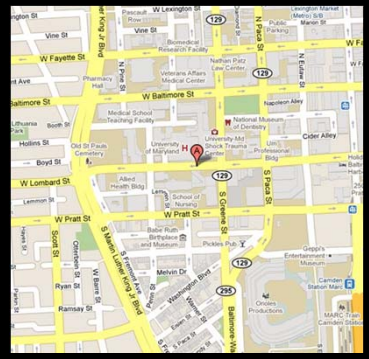
PRESENTATION

- Lighting Depth
  - Exterior Space | North Façade
  - Circulation Space | Main Lobby
  - Large Work Space | Classroom
  - Special Purpose Space | Natatorium
- Electrical Branch Circuit Redesign
- Electrical Depth
  - Wire/Conduit vs. MC Cable Feeders
  - SKM Power Tools Analysis
- MAE Focus
  - Daylighting - Natatorium
- Breadth Topics
  - Mechanical – SHW Natatorium
  - Structural – SHW on Roof

SMC CAMPUS CENTER

BUILDING OVERVIEW

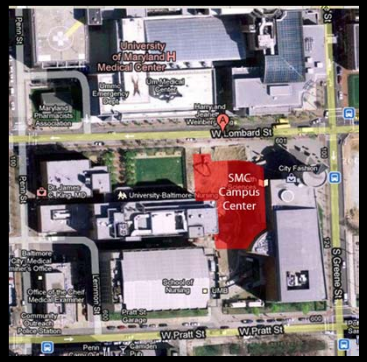
- Site and Location
  - University of Maryland Baltimore Campus
- Size
  - 110,000 Square Feet
- Total Project Cost
  - $43,400,000
- Primary Functions
  - Education Spaces
  - Food and Dining
  - Health and Relaxation
  - Recreational Spaces



SMC CAMPUS CENTER

BUILDING OVERVIEW

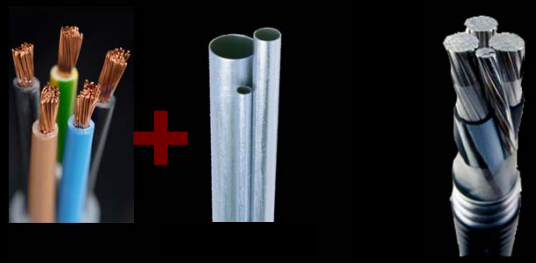
- Site and Location
  University of Maryland Baltimore Campus
- Size
  110,000 Square Feet
- Total Project Cost
  $43,400,000
- Primary Functions
  Education Spaces
  Food and Dining
  Health and Relaxation
  Recreational Spaces
- Owner
  University of Maryland
- Architect
  WTW Architects, Inc.
- MEP
  Henry Adams, LLC
- Structural
  WBCM
- CM/PC
  Whiting- Turner



SMC CAMPUS CENTER

WIRE/CONDUIT VS. MC CABLE FEEDERS

- Objectives
  - Consider performance related issues between copper and aluminum conductors for electrical distribution
    - Electrical
    - Mechanical
    - Reliability
    - Cost
  - Consider economic and schedule impacts of replacing existing copper wire and conduit feeders with all-in-one assembly of MC cable



SMC CAMPUS CENTER

WIRE/CONDUIT VS. MC CABLE FEEDERS

- Electrical
  - Cu conducts current better than Al → need larger wire for Al
  - Increased diameter = more efficient conductor utilization
- Mechanical
  - Larger Al wire approaches tensile strength of Cu
  - Thermal expansion of Al far greater than Cu
- Reliability
  - Cu oxidizes completely, Al oxidation stops → increased life
  - Wide variety of connections to meet requirements for Cu and Al
- Cost
  - Most obvious advantage for Al is lower material and installation cost
  - Al is abundant with a steady market
  - Price of Cu continues to rise

FINAL COMPARISON

	Total Cost	Crew Days	Cost/SF
Existing Wire/Conduit	$185,664.14	44	**$1.69**
Proposed MC Cable	$86,784.25	22	**$0.79**
Savings	**$98,879.89**	**22**	
Savings Percentage	**53%**	**50%**	

								TOTAL COST
LS261	LS241	1	4	#1 AWG	64	5.95	4.05	**640.00**
LS211	EDIM221	1	4	#4 AWG	123	3.65	2.85	**799.50**

SMC CAMPUS CENTER

OVERALL DESIGN GOALS

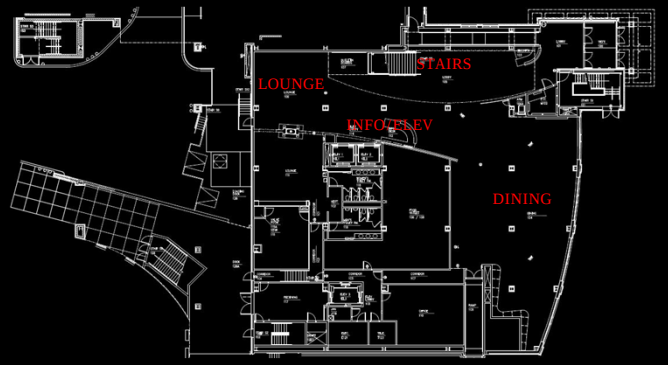
- Modern
  - New building within historic downtown Baltimore, MD
  - Cutting-edge, energy efficient equipment
- Interactive
  - Students, Faculty, and Staff
  - Flexibility for various activities
  - Create a dynamic campus community

SMC CAMPUS CENTER

MAIN LOBBY

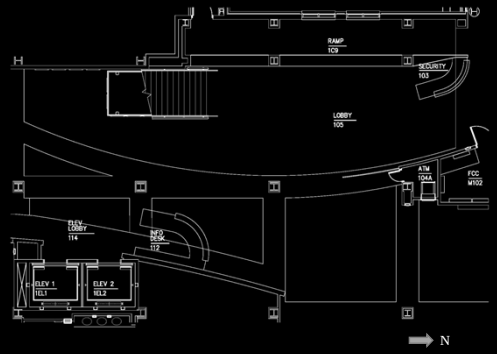
- Design Criteria and Considerations
  - Inviting and Open
    - Variety of Circulation Paths
  - Visual Guidance
    - Dining Facility
    - Student Lounges
    - Information/Elevators
    - Stairs
  - Hierarchy of Elements
    - Curved Ceiling
    - Information Desk
  - IESNA Recommendation
    - 10 fc (H)
  - ASHRAE 90.1-2007 LPD
    - 1.3 W/SF, 2.3 W/SF with decorative

Sentry Center for Business
Manhattan, New York



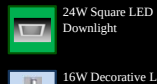
SMC CAMPUS CENTER

MAIN LOBBY



SMC CAMPUS CENTER

MAIN LOBBY



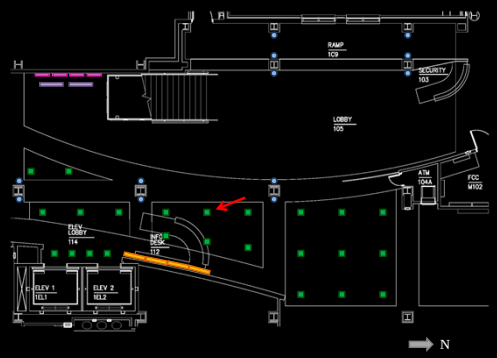
24W Square LED Downlight

16W Decorative LED Wall Sconce

28W Linear Fluorescent Wall Slot

28W Linear Fluorescent Asymmetric Cantilever

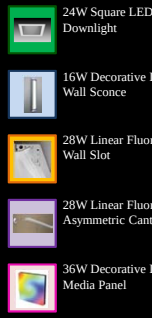
36W Decorative LED Media Panel



INFORMATION DESK

SMC CAMPUS CENTER

MAIN LOBBY



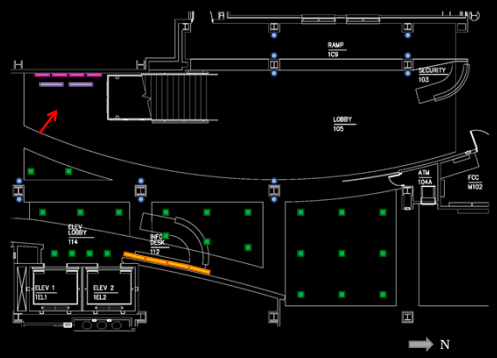
24W Square LED Downlight

16W Decorative LED Wall Sconce

28W Linear Fluorescent Wall Slot

28W Linear Fluorescent Asymmetric Cantilever

36W Decorative LED Media Panel



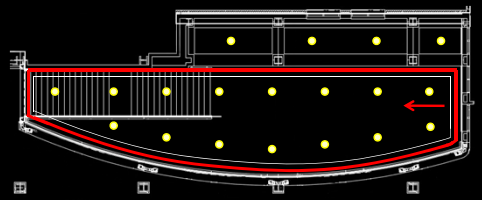
SEATING AREA

SMC CAMPUS CENTER

MAIN LOBBY

55W Round Induction Downlight

6W Decorative LED RGB Cove



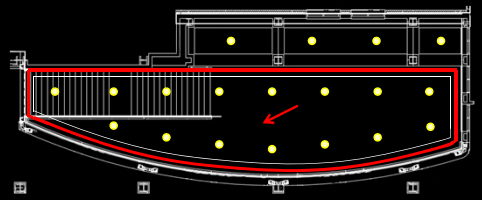
N

SMC CAMPUS CENTER

MAIN LOBBY

55W Round Induction Downlight

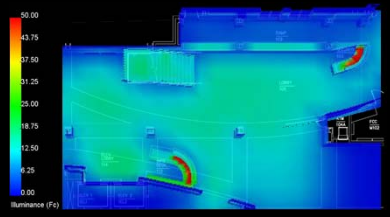
6W Decorative LED RGB Cove



N

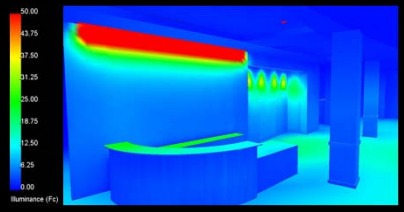
SMC CAMPUS CENTER

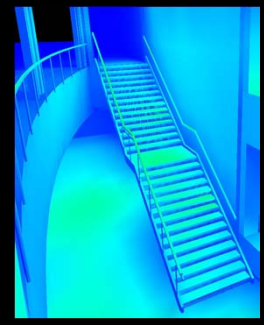
MAIN LOBBY



Main Lobby Lighting Performance		
	Recommended	As Designed
General Ambient (H)	10 fc	14 fc
Lighting Power Density (W/SF)	1.3 / 2.3	1.84

- Design Summary
  - Welcoming
  - Provides Visual Guidance
  - Hierarchy of Elements
  - Meets IESNA and ASHRAE LPD





SMC CAMPUS CENTER

CLASSROOM

- Design Criteria and Considerations
  - Dynamic Visual Environment
    - Classroom | Meeting | Audiovisual
    - Flexibility of light levels
    - Flynn Impressions → Spacious vs. Closure
  - Accent Focal Walls
    - Front → whiteboard, podium, AV screen
  - IESNA Recommendation
    - Reading/Writing: 30 fc (H)
    - Conference: 30 fc (H), 5 fc (V)
    - Whiteboard: 5 fc (V)
  - ASHRAE 90.1-2007 LPD
    - Conference/Meeting/Multipurpose: 1.3 W/SF
    - Classroom/Lecture/Training: 1.4 W/SF

Spacious

Closure

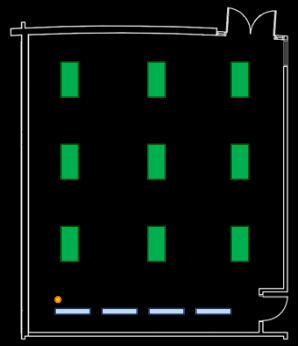
SMC CAMPUS CENTER

CLASSROOM

2/28W Linear Fluorescent
Volumetric

1/28W Linear Fluorescent
Volumetric

38W Round LED
Downlight



SMC CAMPUS CENTER

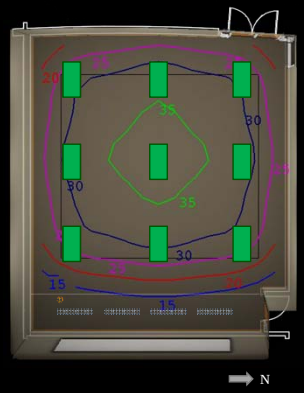
CLASSROOM

2/28W Linear Fluorescent
Volumetric

1/28W Linear Fluorescent
Volumetric

38W Round LED
Downlight

Classroom Lighting Performance		
	Recommended	As Designed
Desks (H)	30 fc	32 fc
Whiteboard (V)	5 fc	7 fc
Vertical (V)	5 fc	14 fc



MEETING MODE

SMC CAMPUS CENTER

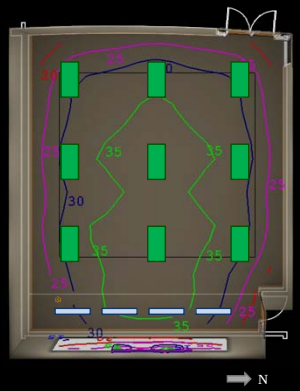
CLASSROOM

2/28W Linear Fluorescent
Volumetric

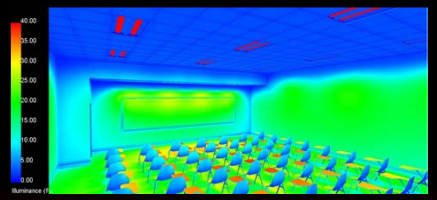
1/28W Linear Fluorescent
Volumetric

38W Round LED
Downlight

Classroom Lighting Performance		
	Recommended	As Designed
Desks (H)	30 fc	33 fc
Whiteboard (V)	5 fc	20 fc



INSTRUCTOR EMPHASIS



SMC CAMPUS CENTER

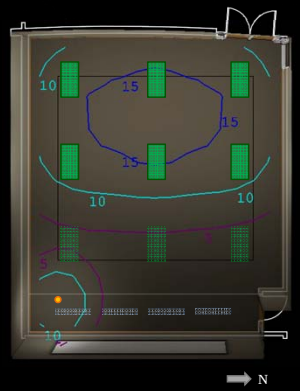
CLASSROOM

2/28W Linear Fluorescent
Volumetric

1/28W Linear Fluorescent
Volumetric

38W Round LED
Downlight

Classroom Lighting Performance		
	Recommended	As Designed
Desks (H)	--	10 fc
A/V Screen (H)	--	1 fc
Podium (V)	--	18 fc



A/V MODE

SMC CAMPUS CENTER

CLASSROOM

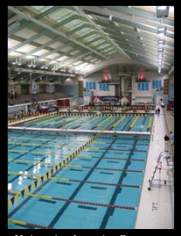
- Design Summary
  - Functional and Flexible
  - Accents Front of Room
  - Excellent Performance

Classroom Lighting Performance		
	Recommended	As Designed
LPD (W/SF)	1.4	0.64

SMC CAMPUS CENTER

NATATORIUM

- Design Criteria and Considerations
  - Glare on Water
    - Direct and Reflected
    - Light Distribution
  - Daylight Integration
    - North Glazing
    - Psychological Impression
  - Environment
    - Strong Chemicals
    - High Humidity
  - IESNA Recommendation
    - Class IV Pool Surface: 30 fc (H)
    - Class IV Pool Deck: 10 fc (H)
    - CV < 0.30
    - Max/Min < 4:1
  - ASHRAE 90.1-2007 LPD
    - Sports Arena: 1.4 W/SF, 2.4 W/SF with decorative



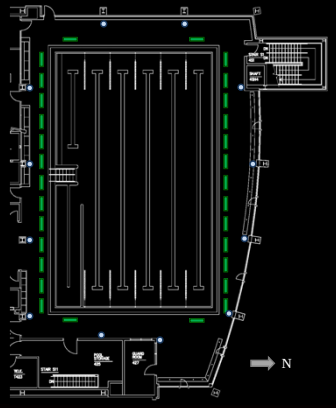
University Aquatics Center
Minneapolis, Minnesota

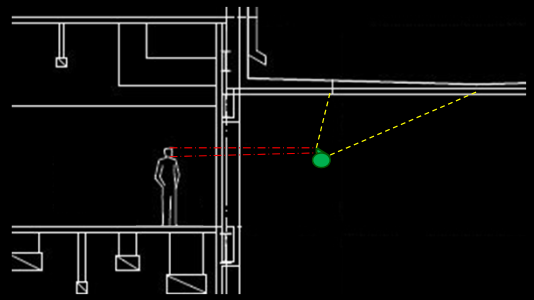
SMC CAMPUS CENTER

NATATORIUM

3/54W Linear Fluorescent
Forward Throw

20W Decorative LED
Wall Sconce



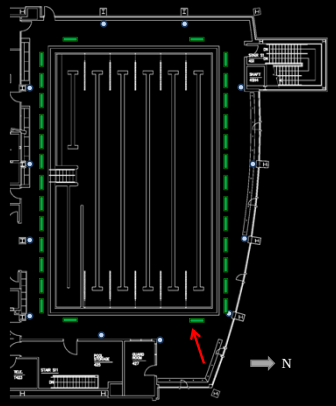


SMC CAMPUS CENTER

NATATORIUM

3/54W Linear Fluorescent
Forward Throw

20W Decorative LED
Wall Sconce

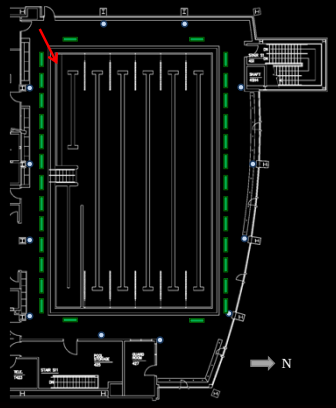


SMC CAMPUS CENTER

NATATORIUM

3/54W Linear Fluorescent
Forward Throw

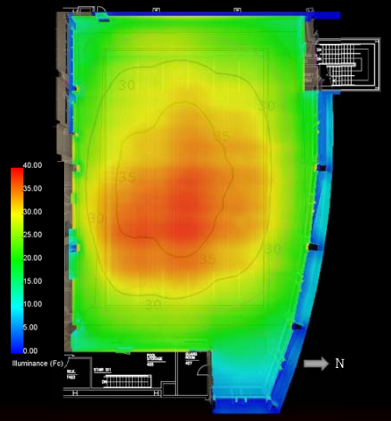
20W Decorative LED
Wall Sconce



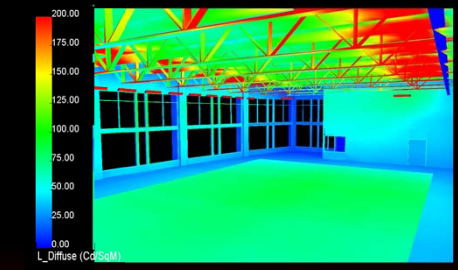
SMC CAMPUS CENTER

NATATORIUM

Natatorium Lighting Performance		
	Recommended	As Designed
Pool Surface (H)	30 fc	33 fc
Pool Deck (H)	10 fc	25 fc
CV	< 0.30	0.09 | 0.14
Max/Min	< 4:1	1.56 | 2.53
LPD (W/SF)	1.4 | 2.4	0.85



- Design Summary
  - Eliminates Glare Problems
  - Comfortable, Relaxing Environment
  - Integrate with Daylighting

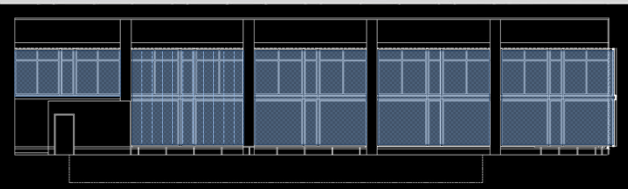


SMC CAMPUS CENTER

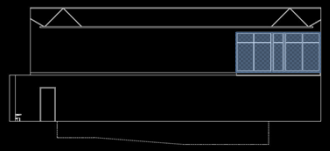
DAYLIGHTING - NATATORIUM

- Objectives
  - Complete a shading study for skylight implementation
  - Improve quality of daylight integration from the north façade
  - Provide a comprehensive daylighting analysis to maximize lighting energy savings throughout the year

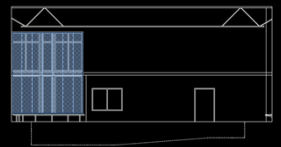
- Building Specifics
  - Location: Baltimore, MD
  - Latitude: 39.29 N
  - Longitude: 76.61 W
  - Electric Lighting: Indirect Asymmetric (T5HO – 5000 lms)
  - Target Illuminance: 30 fc



North Elevation



West Elevation

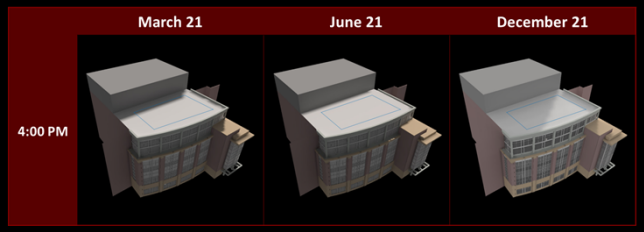


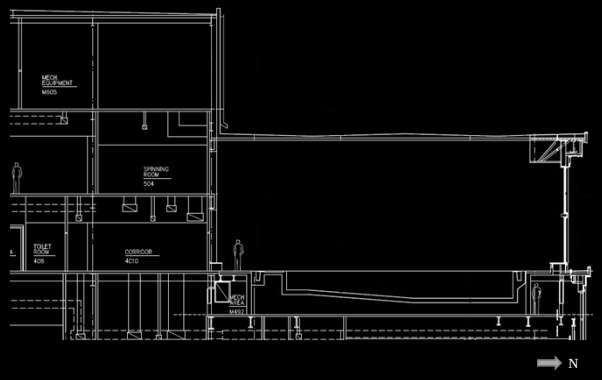
East Elevation

SMC CAMPUS CENTER

DAYLIGHTING - NATATORIUM

- Mechanical Penthouse Shading Study

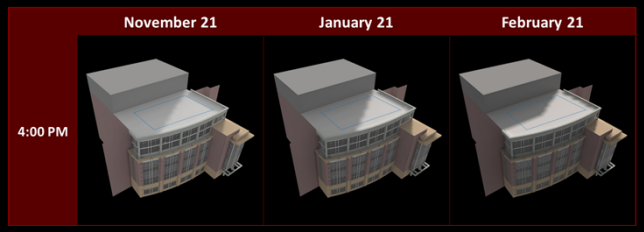


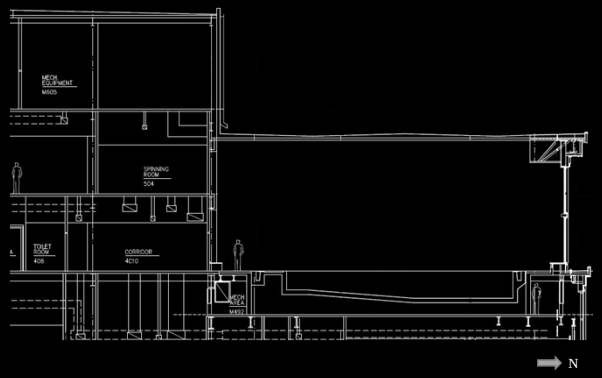


SMC CAMPUS CENTER

DAYLIGHTING - NATATORIUM

- Mechanical Penthouse Shading Study

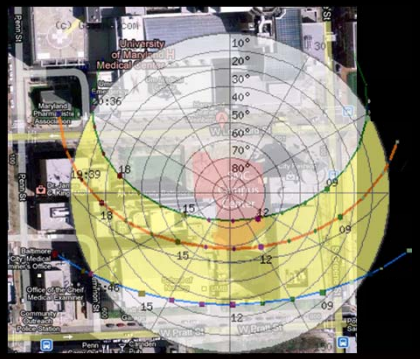


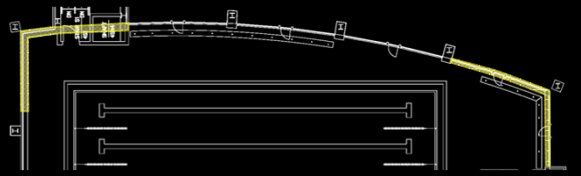


SMC CAMPUS CENTER

DAYLIGHTING - NATATORIUM

- Direct Sun Penetration

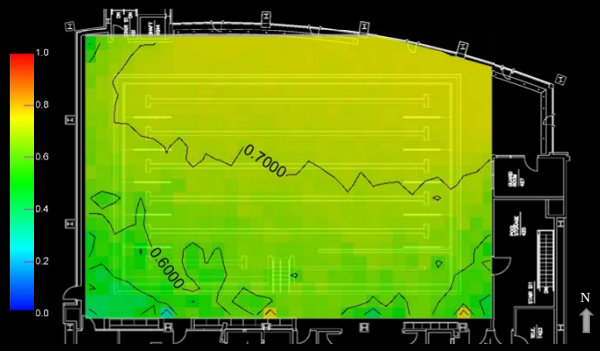




SMC CAMPUS CENTER

DAYLIGHTING - NATATORIUM

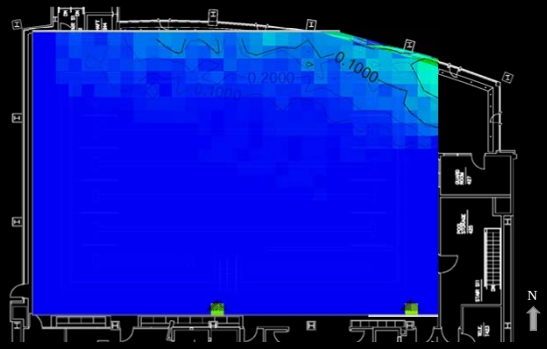
- Continuous Daylight Autonomy – 30 fc



SMC CAMPUS CENTER

DAYLIGHTING - NATATORIUM

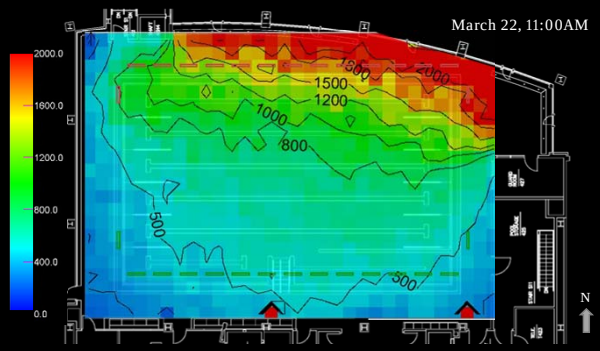
- Threshold Illuminance - 300 fc



SMC CAMPUS CENTER

DAYLIGHTING - NATATORIUM

- Daylight Distribution

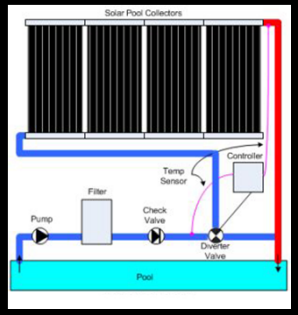


- Performance Summary
  - Manual control of shades to minimize direct sun penetration
  - 37% lighting energy savings (9750 kWh)
  - Connection to outdoors promotes relaxation

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Base	1166.4	1080.0	1217.7	1147.5	1080.0	1171.8	1117.8	1196.1	1193.4	1166.4	950.4	855.9	13343.4
Optimal	422.7	346.13	327.54	255.47	202.24	207.84	189.65	240.88	310.08	335.68	340.14	333.64	3512.03
Algorithm	430.43	352.22	331.79	264.52	207.88	215.2	195.79	249.99	317.87	341.86	345.95	339.93	3593.5
Savings	735.96	727.77	885.9	882.97	872.11	956.59	922.0	946.1	875.52	824.53	604.44	515.96	9749.89

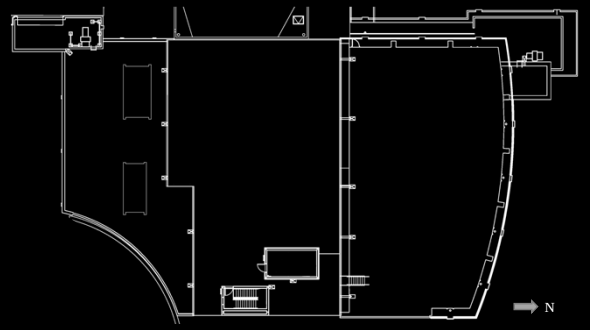
	January	February	March	April	May	June	July	August	September	October	November	December	Total
Base	2332.8	2160.0	2435.39	2295.0	2160.0	2343.6	2235.6	2392.2	2386.8	2332.8	1900.8	1711.8	26686.8
Optimal	1589.1	1426.13	1545.24	1402.97	1282.24	1379.64	1307.45	1436.98	1503.48	1502.08	1290.54	1189.54	16855.43
Algorithm	1596.83	1432.22	1549.49	1412.02	1287.88	1387.0	1313.59	1446.09	1511.27	1508.26	1296.35	1195.83	16936.9
Savings	735.96	727.77	885.9	882.97	872.11	956.59	922.0	946.1	875.52	824.53	604.44	515.96	9749.89

SMC CAMPUS CENTER

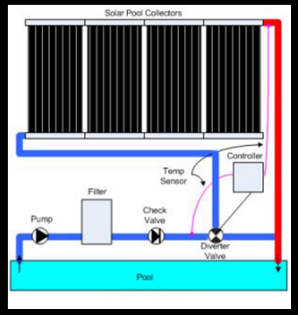


MECHANICAL – SOLAR HOT WATER

- Objectives
  - Reduce existing steam pool heating costs
    - $13.47/MMBtu of steam
  - Promote an environmentally friendly campus
  - RETScreen Energy Software
    - Energy Production Evaluation
    - Life Cycle Cost of System
    - Greenhouse Gas Emissions Reduction



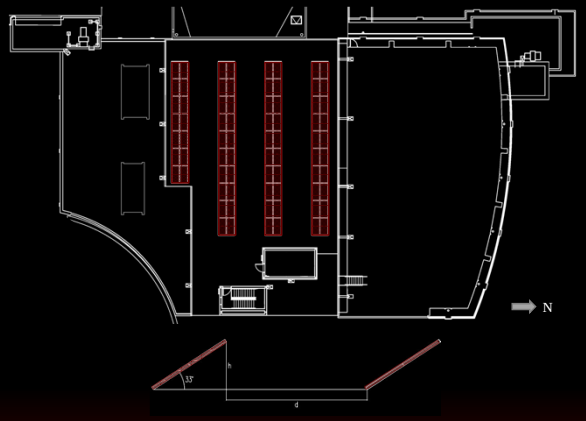
SMC CAMPUS CENTER



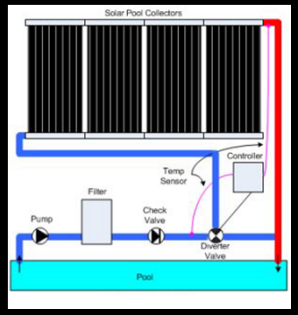
MECHANICAL – SOLAR HOT WATER

- Objectives
  - Reduce existing steam pool heating costs
    - $13.47/MMBtu of steam
  - Promote an environmentally friendly campus
  - RETScreen Energy Software
    - Energy Production Evaluation
    - Life Cycle Cost of System
    - Greenhouse Gas Emissions Reduction

COLLECTOR LAYOUT



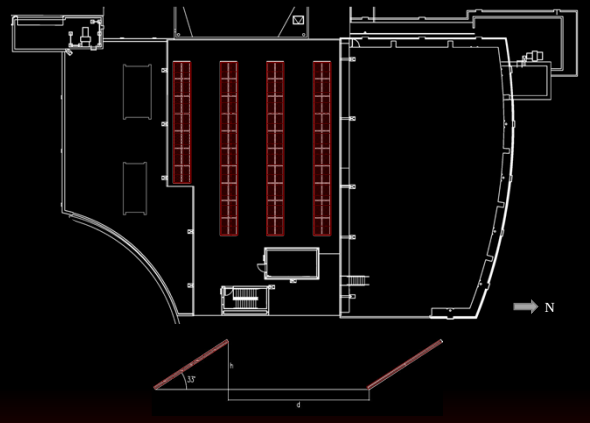
SMC CAMPUS CENTER



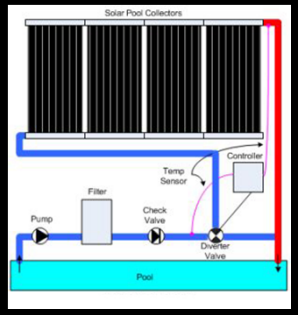
MECHANICAL – SOLAR HOT WATER

- Solution
  - 74 Stiebel Eltron SOL 25 Plus glazed flat plate collectors
  - Closed-loop circulation system
  - RETScreen Setup
    - Baltimore, MD weather data
    - Campus Center occupancy schedule
    - Initial system and design costs
    - Pool cover implementation
    - Financial incentives - DSIRE

COLLECTOR LAYOUT

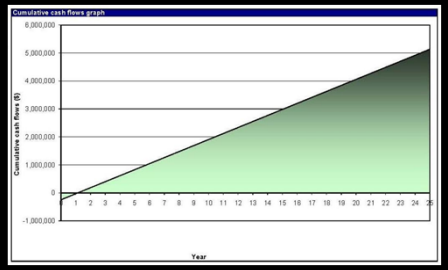


SMC CAMPUS CENTER

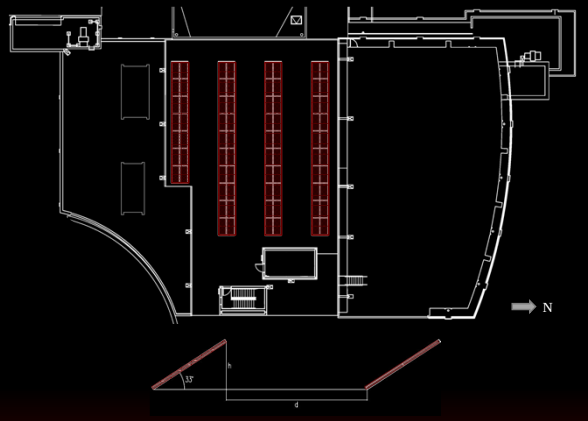


MECHANICAL – SOLAR HOT WATER

- Performance Summary
  - 70% reduction in steam consumption
  - 81.6 tCO2 net annual GHG emission reduction
  - 1.1 year payback period



COLLECTOR LAYOUT



SMC CAMPUS CENTER

CONCLUSION

- Lighting Design
  - Respectful to the urban campus environment, while creating a unique visual identity for the UMB campus
  - Promotes interaction and flexibility through the use of modern equipment
  - Complies with IENSA recommendations and ASHRAE power density
- Daylighting
  - Total system savings of 37% over the course of a year
  - Psychological benefits of connection to the outdoors
- Electrical Design
  - Cost effective solution (50%) for aluminum MC cable feeder replacement
- Mechanical - SHW
  - Promotes green energy projects with a 70% reduction in steam consumption

SMC CAMPUS CENTER

ACKNOWLEDGEMENTS

- Penn State AE Faculty
  - Dr. Mistrick
  - Dr. Houser
  - Prof. Dannerth
  - Prof. Holland
  - Prof. Parfitt
- Henry Adams, LLC
  - Doug Tebera
  - Jim Good
- WTW / WT
  - Barton Schindel
  - Michael Carper
- UMB Campus
  - Kate McManus
  - Bill Crockett
  - Stacy Hosenfeld
  - Mike Krone
- Lutron Technologies
  - Charles Stone
  - Sandra Stashik
  - Shawn Good

All my Family, Friends, and Fellow AE Students

SMC CAMPUS CENTER

COMMENTS AND QUESTIONS