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Where Wellness Begins

Chelsea M. Wheeler

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Thesis Design Application:
Daylight, Ventilation and Vegetation
Focus On Daylighting
Hierarchy Of Elements

Primary Element:
Analyzed Effectiveness
Programmatic Considerations

Natural Light

Secondary Element:
Programmatic Considerations

Fresh Air
Vegetation

Tertiary Element:
conscientious

Community Nutrition Physical Activity
Medical Need Occupant Satisfaction Relaxation/Alertness
Access To Natural Daylight:
Analytic, Programatic and Conscientious Influences On Design

Natural Light
Access To Natural Daylight:
Climate Conditions

Summer months show evidence of high rates of heat gain that could be uncomfortable for occupants. Shading devices should be used to block light from parts of the building occupied during the summer. Since educational facilities are normally closed during the summer, this should not be a large concern. Spring Shading is necessary.

Winter Months show less radiation for the region providing fewer solar gains. Large southern windows with thermal materials could be used to take advantage of the solar energy available to help heat the spaces. Particularly, this will be necessary from December through February.
Radiation levels are greatest during the months of April through September. These months offer the best opportunity for diffused lighting and solar gains. Direct and side lighting will provide more opportunities for radiation gain in the winter months.

Illumination levels throughout the year suggest sufficient light levels for daylighting to accommodate most tasks most days of the year if utilized properly. Clerestory and skylights can be used to take advantage of these levels.
Access To Natural Daylight:
Climate Conditions

Cloud Coverage

Cloud coverage throughout the year is relatively consistent suggesting little direct lighting. This may decrease the solar gains as seen in the above chart. Little direct lighting is expected from November through January. This may reduce the need for external shading devices particularly in the winter.

Temperature Range

The natural temperatures during the school year are below comfort level. Heating will be required. This supports the use of large southern exposures for heat gain. Cooling can be handled through the use of proper ventilation and manually operated shading devices of electrochromic glazing.
In order to develop improved daylighting systems for the individual classrooms and building as a whole, it was necessary to develop a system of testing the building performance. As such, the classroom design developments produced for the new Blodgett Middle School were tested for daylight availability utilizing the daylight simulation software Rhino. Each iteration of the design was tested for daylight area—a spatial indication of availability and daylight autonomy that measures the occupied times in which daylight is available.

These numbers were compared to the existing conditions of Blodgett Middle School and an exemplary WELL building, the CBRE Headquarters in LA.

Tests were used to determine the best depth, height, window area, orientation, and ceiling angle to comply with the classroom requirements. The following pages capture this process that yielded the forms to the right of this page.
### Blodgett School Classroom Lighting Design Studies:

**Daylight Area + Daylight Autonomy**  
Nearwest Side Syracuse NY

<table>
<thead>
<tr>
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<tr>
<td>30 ft x 35 ft</td>
<td>1680 hr.</td>
<td>76%</td>
<td>20 ft x 35 ft</td>
<td>700 ft sq</td>
</tr>
<tr>
<td>15 ft</td>
<td>1050 ft sq</td>
<td>68%</td>
<td>20 ft x 35 ft</td>
<td>700 ft sq</td>
</tr>
<tr>
<td>15 ft</td>
<td>1680 hr.</td>
<td>58%</td>
<td>25 ft x 35 ft</td>
<td>875 ft sq</td>
</tr>
<tr>
<td>15 ft</td>
<td>1680 hr.</td>
<td>88%</td>
<td>25 ft x 35 ft</td>
<td>875 ft sq</td>
</tr>
<tr>
<td>25 ft x 35 ft</td>
<td>1680 hr.</td>
<td>93%</td>
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<td>30 ft x 35 ft</td>
<td>1680 hr.</td>
<td>100%</td>
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**Optimized Classroom Design - Nearwest Side Syracuse NY**

**Light Shelf - Flat Ceiling**

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<td>30 ft x 35 ft</td>
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<td>81%</td>
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<td>91%</td>
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<td>700 ft sq</td>
</tr>
<tr>
<td>30 ft x 35 ft</td>
<td>1680 hr.</td>
<td>84%</td>
<td>25 ft x 35 ft</td>
<td>875 ft sq</td>
</tr>
<tr>
<td>30 ft x 35 ft</td>
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<td>87%</td>
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In order to compare these structures, the floor area was adjusted to match. Similar orientations were also selected to provide the most comparable results. Through testing, the daylighting availability was improved. This can then be adjusted with manual shading devices to accommodate different needs.
Access To Natural Daylight:
Classroom Unit Testing - Comparing Results Existing to Proposed

Existing Conditions - CBRE Headquarters LA

Proposed Conditions - Blodgett Classroom

In order to compare these structures, the floor area was adjusted to match. Similar orientations were also selected to provide the most comparable results.

Through testing, the daylighting availability was improved. This can then be adjusted with manual shading devices to accommodate different needs.

### Existing Conditions - CBRE Headquarters LA

- **Daylit Area Dimensions:** 35 ft x 25 ft
- **Occupied Hours:** 1680 hr.
- **Daylit Area:** 86%
- **Mean Daylight Autonomy:** 81%

### Proposed Conditions - Blodgett Classroom

- **Daylit Area Dimensions:** 35 ft x 25 ft
- **Occupied Hours:** 1680 hr.
- **Daylit Area:** 100%
- **Mean Daylight Autonomy:** 93%

+ 17% Daylight Area
+ 12% Daylight Autonomy
Access To Natural Daylight:
Classroom Unit Testing - Resulting Spaces
The design and selected classrooms for the new Blodgett Middle School require primarily southern exposure and access to daylighting all year. This required a tiered system of organization. The classrooms were arranged according to the mid season solar angles of Syracuse NY allowing for adequate spacing to ensure access to southern exposure by every classroom.

From this organizational strategy, the program was delineated. The next several slides describe this process of program organization.

### Sun Angle Diagrams - Solar Noon By Season

- **South - North Section Facing West -- Winter Sun Angles - ~23.5**
- **South - North Section Facing West -- Fall/Spring Sun Angles - ~47**
- **South - North Section Facing West -- Summer Sun Angles - ~75.5**
Access To Natural Daylight:
Classroom Organization Strategies - Classrooms

Classrooms:
- Number of Students: 410
- Required Number of Classrooms: 27
- Number of Classrooms Provided: 36
  - Traditional Classrooms: 28
  - Innovative Work Zones: 8

Southern Exposure:
- All Classrooms Are Provided With Southern Exposure Utilizing Light Shelves to Diffuse Light Into the Spaces Providing Proper Circadian Rhythm and Improved Alertness
Western Exposure:

Evening Activities and Relaxed Settings Benefit From Sunlight During The Latter Half Of The Day, Providing Warmer, Calming Infrared Wave-lengths From The lower Sun-Angles
Access To Natural Daylight:
Classroom Organization Strategies - Gymnasium and Auditorium

Northern Exposure:
Double Height Spaces Are Tucked Into The Back With Light From The Courtyards. The Gym And Auditorium Were Ideal Because They Need Little Natural Light And Provided Height To Elevate The Classroom Spaces Out Of Shadows
Access To Fresh Air And Ventilation:
Programatic and Concienscious Influences On Design
Access To Fresh Air And Ventilation:
Syracuse NY Climate Conditions

Climate Considerations For Fresh Air and Ventilation:

Wind Velocity

Wind velocity is greatest in March and least in June. This could pose a problem in the summer using cross ventilation as the primary cooling method but since the building will be largely uninhabited during the summer months, this will only be a concern in a few areas. Winter winds average around 12 mph.

Wind Rose

Wind on the site according to this wind rose approaches from the west. To keep the cold winter winds at bay, evergreen plants can be utilized on the west end of the site to cut the wind and ac as a buffer.
Blodgett Middle School is an old, traditional school building. The construct conscribes to a U-shaped morphology in which the corridor spaces wrap the interior of the building pushing the classes to the exterior walls of the U. Circulation cores are found at four points offset from the corners allowing as many spaces as possible to have two exterior surfaces. The lowest level maintains a double loaded corridor.
The circulation path of Blodgett Middle School as it exists snakes around the interior of the U-shaped parti of the building. Classrooms are accessed from this internal corridor. The only available aperatures consequently are on the outer edges of the U-shaped building, this can have negative effects on the flow of air into the classrooms.
Access To Fresh Air And Ventilation:
Comparison - Existing Building - Classroom Ventilation

Cross-ventilation is prevented in the existing Blodgett Middle School due to the Traditional U-shaped morphology of the building. Air is only able to enter the room from one side of the classroom because the adjacent corridor prevents additional aperatures. As such, there is no outlet for the air so the path of air is blocked, preventing adequate ventilation. This can create a buildup of warm, stale air that is rich in CO2, decreasing student attention and health.

Air Levels:
- Hot Stale Air
- CO2
- Cool Fresh Air

Predominant Wind
- Direction: SW - W
- Wind Range: 5-35 mph

Average Wind Speed:
- Annual Mean: 9.5 mph
- Spring: 10 mph
- Winter: 12 mph
- Fall: 9 mph
The proposed Blodgett Middle School utilizes circulation patterns as a tool by which every classroom can be provided with cross ventilation with predominant wind inputs from the South and West to accommodate the Southwestern winds. In order to achieve this, a single corridor is created perpendicular to the classrooms with three fingers of circulation branching off of this corridor to allow side entry into three levels of tiered classroom spaces. This allows for more circulation and greater levels of oxygen in the classrooms which can improve alertness, attention, and respiratory health.
Access To Fresh Air And Ventilation:
Comparison - Proposed Building - Circulation

The role of circulation in the design of cross ventilation is best observed through the inspection of a single strand of circulation. The building steps up as it reaches farther north providing three main levels for education. Students access the three strands from the primary corridor connecting the three strands. From these strands or fingers of circulation, the second and third floor can be accessed. Emergency egress is provided at the end of each finger. These strands provide entry to classroom spaces on both the East and West sides of the corridor.

Below demonstrates the central strand of circulation in relation to the programmed spaces. The pink toned boxes represent the classroom spaces to be accessed.
Access To Fresh Air And Ventilation:
Comparison - Proposed Building - Circulation

Accessing the classrooms from the side of the room leaves the long edges free for aperatures. Minimizing circulation parallel to the classrooms provides better ventilation with increased area for aperatures.

Below demonstrates the circulation into the individual spaces. The circulation strands access the classrooms from the short sides.
Access To Fresh Air And Ventilation:
Comparison - Proposed Building - Circulation

Below demonstrates how the ventilation and circulation of a single classroom work together.

The displayed classroom is a second story room with Southern exposure.
The typical classroom in the proposed Blodgett Middle School utilizes air inputs from the South with an average velocity of 9.5 mph. The input is placed low while the output apertures are placed high on the opposite exposure. This forces air into the classroom and sweeps the air up expelling the hot stale air that accumulates at the upper portions of the room. In so doing, the CO2 is removed from the class and replaced by fresh air improving alertness, focus, and respiratory health.

Access To Fresh Air And Ventilation:
Comparison - Proposed Building - Unit Ventilation - Typical

This forces air into the classroom and sweeps the air up expelling the hot stale air that accumulates at the upper portions of the room. In so doing, the CO2 is removed from the class and replaced by fresh air improving alertness, focus, and respiratory health.
Access To Fresh Air And Ventilation: Comparison - Proposed Building - Unit Ventilation

There are three classrooms in the proposed Blodgett Middle School that do not comply with the typical design. These spaces still utilize air in-puts from the South with an average velocity of 9.5 mph. The input is placed low while the out-put apertures are placed high. The outputs however are placed on the same exposure as the in-puts.

This forces air into the classroom and sweeps the air up expelling the hot stale air that accumulates at the upper portions of the room from the upper aperture as shown below. In so doing, the CO2 is removed from the class and replaced by fresh air improving alertness, focus, and respiratory health.
Access To Green Space And Vegetation:
Programatic and Consciensious Influences On Design
Access To Green Space And Vegetation: Existing Conditions

Current conditions at Blodgett Middle School offer students with minimal access to outdoor space and vegetation. The primary outdoor physical activity spaces are provided by the fields adjacent to the school building. The site itself offers little recreational use and greenery. The spaces available on site are two playgrounds that would be better suited for an elementary school than a middle school. This creates a need for the relaxation benefits, physical activity opportunities, and provision of fresh air created by vegetated, outdoor spaces.

The addition of green spaces would also add the opportunity for students to utilize apertures to view the scenery acting as visual relief which is believed to improve eye strength and concentration. The vegetation can also be used to mitigate light levels in the warmer seasons and act as a buffer between the school and community.

The Blodgett Middle School site currently offers two symmetrical playgrounds with a connecting green strip. The rest of the site is utilized for parking.

Fields across the street from the school offer community activities and physical activity. These spaces should be maintained.
The new Blodgett Middle School proposal attempts to fully engage the site, offering students and the community the best possible use of the land available to them. The Near Westside of Syracuse NY offers few recreational green spaces. By creating a series of green courtyards and reclaiming the rooftops as green spaces, the students are able to engage the outdoor environment on a deeper level improving attitudes, lighting, and air quality. By creating a visually appealing environment separated from the surrounding environment students are provided with a safe environment for physical activity and social engagement.

Terraced paths and zones create non-educational outdoor support and recreation spaces for student use.

Educational Court-yards create educational zones for student use and access to light, air, and scenery.
There are two types of green spaces incorporated into the new Blodgett Middle School design: non-educational terraced paths / zones and educational courtyards. The first, terraced paths and zones is intended to serve recreational needs supporting exterior cafeteria programs, community gardens, additional outdoor gym spaces, and recreational areas for students, parents and the community at large.

These outdoor spaces provide vegetation, improve area quality, buffer the school yard from the surrounding area, to ensure a relaxing non-distracting educational environment, physical activity, and comforting views. The outdoor terraces utilize walking paths, study areas with benches, gardens, and outdoor dining areas.

The terraced, non-educational outdoor spaces utilize the building rooftops and side yards of the school to ensure the full utilization of the Schools site while preserving green spaces adjacent to classrooms for educational purposes. By placing vegetation and green spaces on the roofs, there is an added level of insulation that increases the overall R-value of the classrooms.
Access To Green Space And Vegetation:
Terraced Paths & Recreational Zones - Community Gardens

The terraced path and zone system is organized to set up a number of adjacencies programatically in order to create health supporting relationships. This is exemplified by the juxtaposition of the cafeteria spaces and outdoor dining areas to the community gardens. The community gardens not only create a pleasant environment that reminds students of the importance of fresh grown vegetables but also provides a supplemental food source. Student grown fruits and vegetables can be utilized in the cafeteria to supply students with improved nutrition. Since these vegetables would be student grown, there would be a greater potential for student enthusiasm in healthy food options. The juxtaposition offers practical and educational value.
Access To Green Space And Vegetation:
Terraced Paths & Recreational Zones - Community Gardens

This image demonstrate the type of environment created by the juxtaposition of outdoor spaces to programatic spaces within the school. Specifically, this image looks at the community gardens, facing the side entrance of the school with the cafeteria to the left. Students are engaged in the gardening.

In the background, the terraced rooftops begin to appear, offering further opportunities for engagement. These terraces step down towards the south offering yearly light for activities, safety, and vegetation growth.
The second type of green space incorporated into the proposed Blodgett Middle School is educational courtyards. These spaces are designed to offer each classroom its own outdoor space. These courtyards offer daylight availability, fresh air, and visual relief to the classrooms as well as space for outdoor experiments and classroom instruction during the warmer months.

As a result of these outdoor spaces, students have a greater potential for alertness due to improved air quality and light levels that regulate the students’ circadian rhythm. Additionally, the visual relief of the courtyards offers comfort and relaxation to the often stressful educational environment.

Terraced, educational courtyards utilize the teared morphology of the building and offer additional classroom space. The Classrooms are designed to open up onto the courtyard if desired through the use of southern exposed sliding aperatures. The courtyards average two thirds of the size of the classroom proper.
Access To Green Space And Vegetation: Terraced Paths & Recreational Zones - Community Gardens

This image demonstrate the type of environment created by the juxtaposition of outdoor spaces to classrooms. The spaces are connected to the classrooms. Courtyard spaces are usually connected to two classrooms to allow for greater collaboration when desired by the teachers. Spaces are flexible and can be outfitted with furniture, vegetation, or equipment depending on the schools needs.

In addition to outdoor spaces, these courtyards introduce light, air, comfort and privacy to the classroom spaces. The courtyards are invited into the space to improve student health and comfort.
Access To Green Space And Vegetation: Terraced Paths & Recreational Zones - Community Gardens

The allocation of vegetation at the site scale attempts to interact with the students and the city. The North-East of the site is left open in the direction of downtown Syracuse, inviting students and providing a building facade and main entrance while the South-West of the site is buffered from the community to create safe private zones for students during the school day.

The use of vegetation on the South-West of the site helps break the western winds and diffuse the southern sun in the summer months to prevent overheating.
Resulting Documents and Designs
Plans and Sections

Vegetation  Fresh Air  Natural Light