ASCE Charles Pankow Foundation Architectural Engineering Student Competition

Team Registration Number **05-2013**

Our team submitted designs in the following categories:

Building Integration Design
Structural Systems
Mechanical Systems
Lighting/Electrical Systems
Innovative Construction Management and Construction Methods

Building a Better Community

The community of Reading, Pennsylvania is in a concerning state. In 2011, *The New York Times* ranked Reading as the poorest city in the United States on the basis of having the largest percentage of its population living in poverty. The Reading School district is in a comparable condition. The school district is in "Corrective Action II" as defined by the No Child Left Behind Law, and has lately achieved mixed results in national and state standardized test scores.

Despite the city's recent shortcomings, there is still a reason to hope. Vaughn D. Spencer, mayor of Reading, assures a promising future for his citizens: "In the middle of every difficulty lies opportunity."

The ASCE Charles Pankow Foundation Student Competition provided our design team the opportunity to shape the future of the Reading community. With an innovative, high-performance elementary school, our design team hopes to educate and inspire the next generation of Reading. The competition provided us the opportunity to capture the potential that Mayor Spencer alluded to.

It provided us the opportunity to build a better community.

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Project Goals

The mission of the Charles Pankow Foundation is “to advance innovations in building design and construction, so as to provide the public with buildings of improved quality, efficiency, and value”. The 2013 ASCE Charles Pankow Foundation Student Competition forwards this mission by challenging students to use an integrated design method to create a high-performance elementary school located in the urban setting of Reading, Pennsylvania.

Working from the challenges listed in the student competition guidelines and the mission of the Charles Pankow Foundation, our design team formed our own project goals. These three goals establish our team’s core values, and are crucial to the way we modeled our team’s design and decision-making processes.

1. Build a better Reading community through construction and implementation of school and community programs

2. Design the elementary school to high-performance standards

3. Utilize an integrated design approach to maximize quality, efficiency, and value of the final built product

The definition of high-performance is essential to our approach to the project. The competition states the following as a definition for high-performance, taken from the Energy Independence and Security Act of 2007:

“The term 'high-performance building' means a building that integrates and optimizes on a life cycle basis all major high performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations”

Our team added terms to the definition of high-performance for this project, adapting principles from the Collaborative for High-Performance Schools [1]

- Healthy
- Energy, material, and water efficient
- Thermally, visually, and acoustically comfortable
- Easy to maintain and operate
- Commission to ensure building performance
- Safe and secure
- Effective as a tool for teaching about environmental responsibility
- Architecturally stimulating
- Flexible for multiple school and community use

A Challenge to Unite Us

The team understood the benefits of effectively working together and planning ahead. Using communication and teamwork, success could be achieved. For these reasons, the team came together to form a fully integrated process.

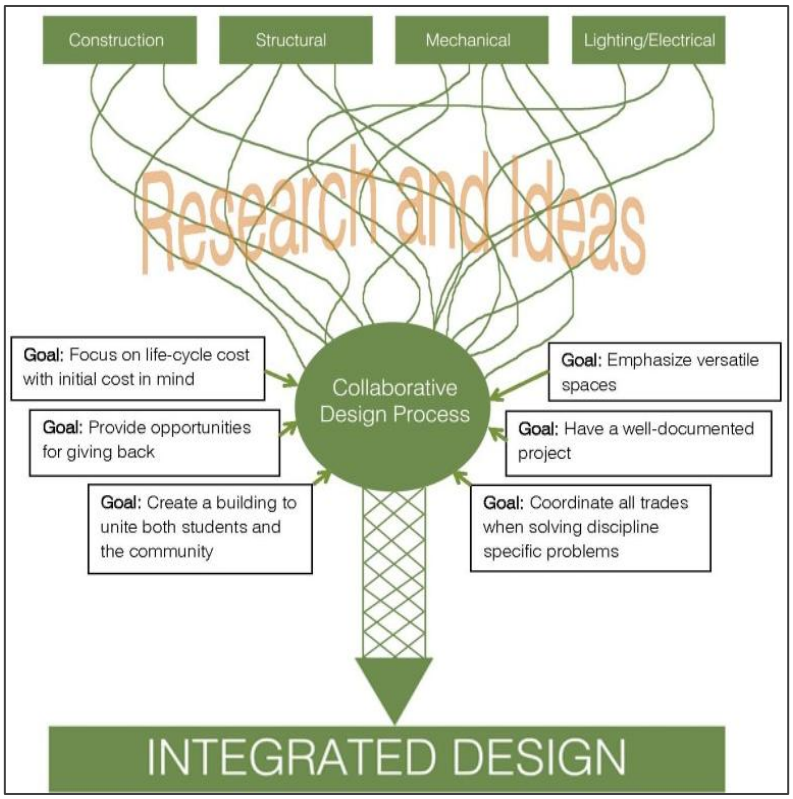


Fig 1: Abstract Design Process Map

Team Organization

In order to have an organized team which works efficiently, team members coordinated schedules to determine when everyone was able to be together. One of the team's key desires was to meet in person on a regular basis to track progress, discuss ideas and make decisions. The Computer Integrated Construction (CIC) Research Program's BIM Planning Guide (in future reference shortened to *BIM Execution Plan*) was implemented to align our team and discipline goals, consider lead-lag of design activities, and develop process maps that visually depict efficient flow of work.

To properly schedule and coordinate work, the group collaboratively created a process map, shown on page 3 of the supporting documents, with goals for specific milestone dates. Doing this ensured that group members were held accountable in order to keep the entire project on schedule. Status updates to the process map were discussed at weekly team meetings. To use meeting time most effectively, a minutes format was used which organizes issues by level of importance which can be seen on page 2 of the supporting documents. An abstract of the team alignment process is also shown in Figure 1.

Team Whiteboard Sessions

When making decisions, the team used the same general format. One week ahead of a design meeting, the topic of the decision to be made was announced to all group members. This allowed everyone to use the week prefacing the meeting to organize research and their positions on various decision options. During design meetings, the team gathered around an interactive whiteboard and listed all ideas by team members. The interactive whiteboard added a visual element to the team brainstorming process. Models and images were revised using the intelligent capabilities of its 87-inch screen and "smart" styluses. Once researched possibilities were listed; the team would discuss advantages and disadvantages of each from a total design perspective, leading to a free-formed discussion about the topic. This organic discussion led to innovative solutions and the transformation of an individual member's ideas. These discussions would eventually lead to a consensus which best satisfied the team design goals.

Team Coordination

To have an integrated design, the team knew that coordination would be crucial. The team coordination process was continual from the beginning of the project. Continual coordination led to minimal re-work issues between building systems during design. Coupling these efforts with the team decision making process, the group was able to use innovative elements such as precast façade panels and cogeneration system.

Project Overview

The proposed elementary school design is a 100,000 square foot integrative community and educational facility. Not only will it be a high performance learning center during the day but also an area of recreation and community use during non-school hours. Figure 2 below highlights many of our team's design features. The community assets of the school include a multipurpose gymnasium which doubles as a natural disaster relief shelter, a natatorium, multiple meeting spaces, and a 24-hour health clinic. A major change from the competition guidelines is the inclusion of a competition swimming pool beneath the multipurpose gymnasium. Design of the swimming pool area required an integrative approach. Height and span requirements led to the use of long span cellular beams, which allow ductwork and the light-truss to easily pass through the circular holes in the beam webs. Furthermore, the pool is heated in an innovative way using combined heat and power through four 65kW natural gas microturbines. However, the pool is still an alternative to the owner (Reading School District), and the owner may opt out of the proposed design for the swimming pool completely. Please refer to page 6 of this Integration Narrative for more detailed information on the swimming pool and the owner's alternatives.

Ventilation and space heating/cooling loads are controlled through a combined 100% outdoor air displacement and radiant heating and cooling system to provide a comfortable thermal environment for the students. Further increasing the indoor environmental quality of the school, indirect lighting in the classrooms provides uniform, ambient, and shadow-less light. The south façade incorporates overhangs to protect against sunlight disturbing the learning environment. To facilitate construction and accelerate the schedule to 14 months, prefabricated façade panels will be used. The cost of this facility will be roughly $24,000,000 should the owner decide to include the swimming pool into the building's footprint. Please refer to page 14 of the Innovative Construction Narrative for more information on the facility's cost.

Throughout the design process, our team used extensive design review strategies, including the use of building information modeling (BIM). These efforts are detailed on pages 13 and 14 of this Integration Narrative.

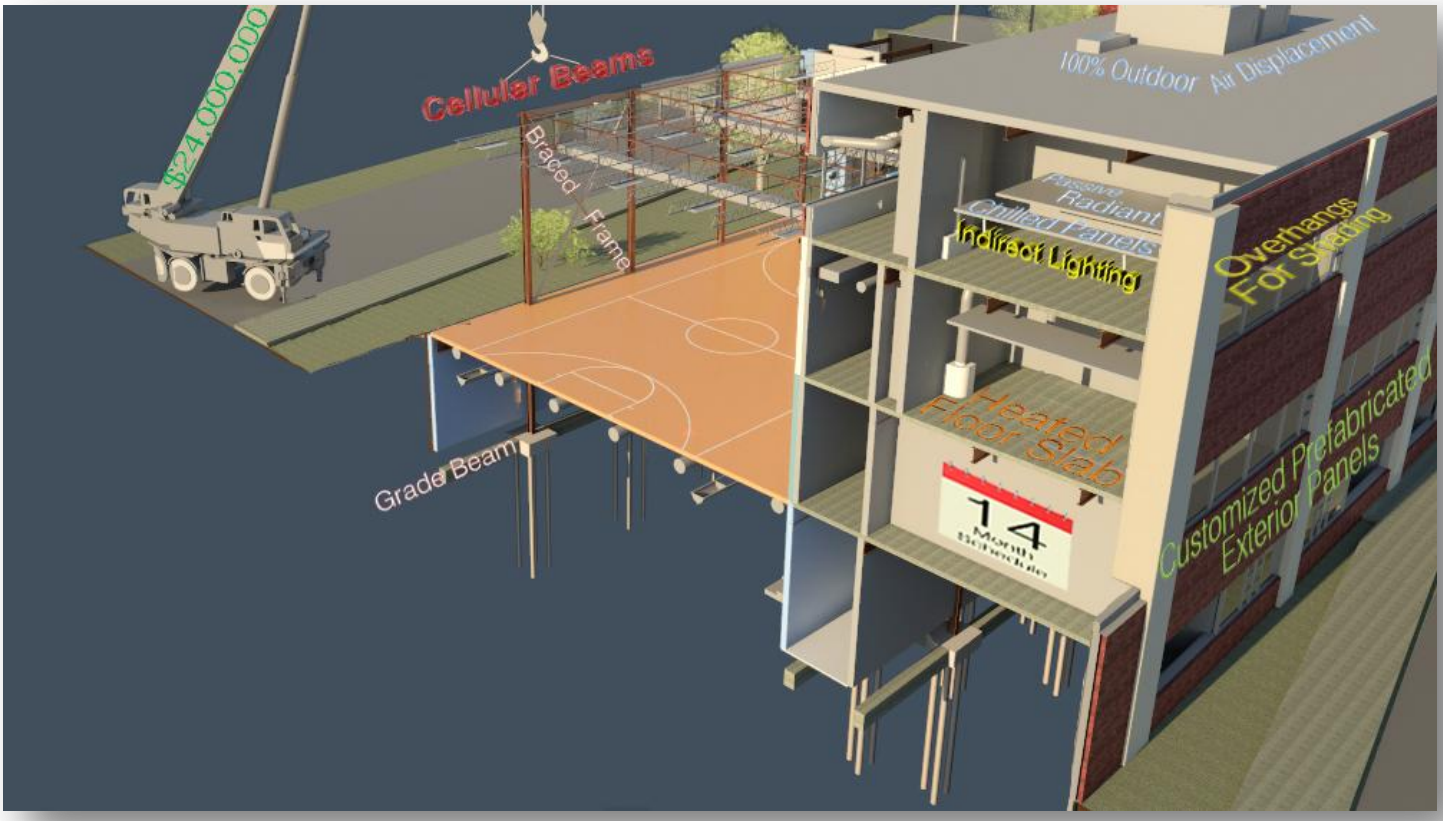


Fig 2: 3D Isometric View of Integrative Design

Building Site

The building location is an integral part of our overall design concept, and was an important team decision. This project is unique in the perspective that our design team was able to choose the building site location. The competition stated that we may choose a site along 13th Street for the purposes of defining utility tie-in points. Instead of choosing the location based on utility tie-ins alone, our team performed an extended study of possible locations involving other, more important factors.

Based on the extended site study, the school location was selected to be at the **intersection of 13th Street and Union Street**, which enhances constructability in all facets of the building design process. The intersection rests 0.75 miles north of the Warren Street Bypass, easing product delivery. Its open layout presents charming views of the neighboring elementary school and Albright College. Finally, the area is zoned for small utilities, which authorizes the elementary school's cogeneration plan.

Furthermore, safety is a large concern in Reading, and the site was selected to avoid high-crime areas. Our team wanted the community to feel safe sending their children to the new elementary school. Our team noticed a geographical trend in crimes throughout the city of Reading. Figure 3 displays all the crimes that occurred in one week in October. Various time periods throughout the year were further analyzed, and the team highlighted areas consistently exhibiting high-density crime. As a result, the school location, shown in Figure 4, was selected to avoid the high-density crime areas.

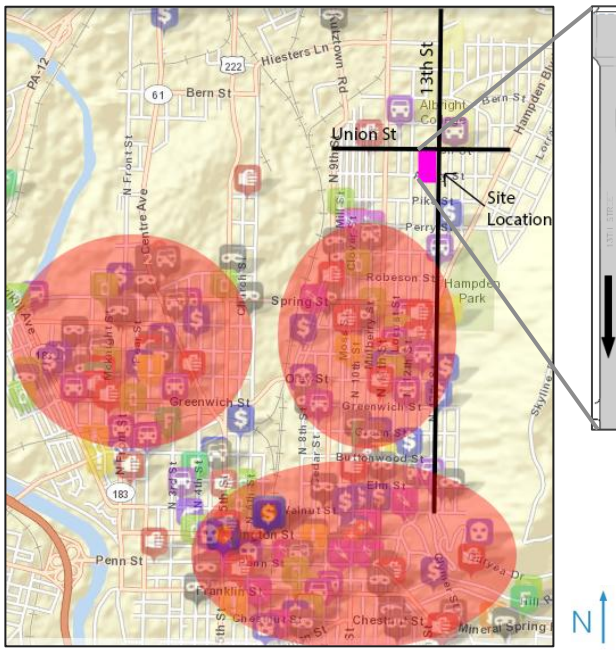


Figure 3: Crime Density for Reading Based on the Week of October 8-15 2012 (Crimemapping.com)

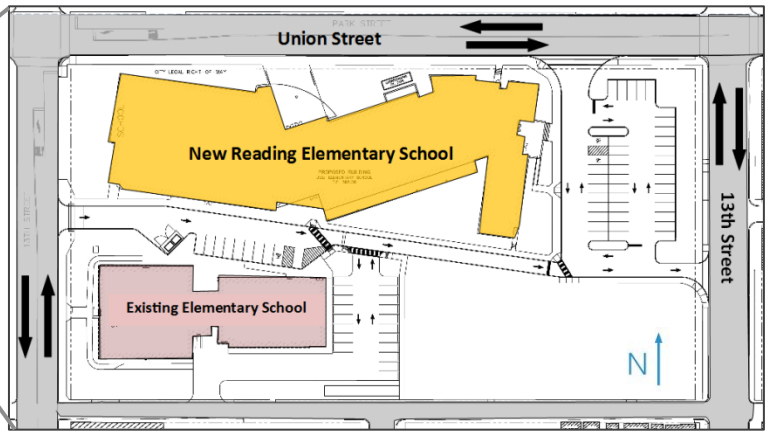
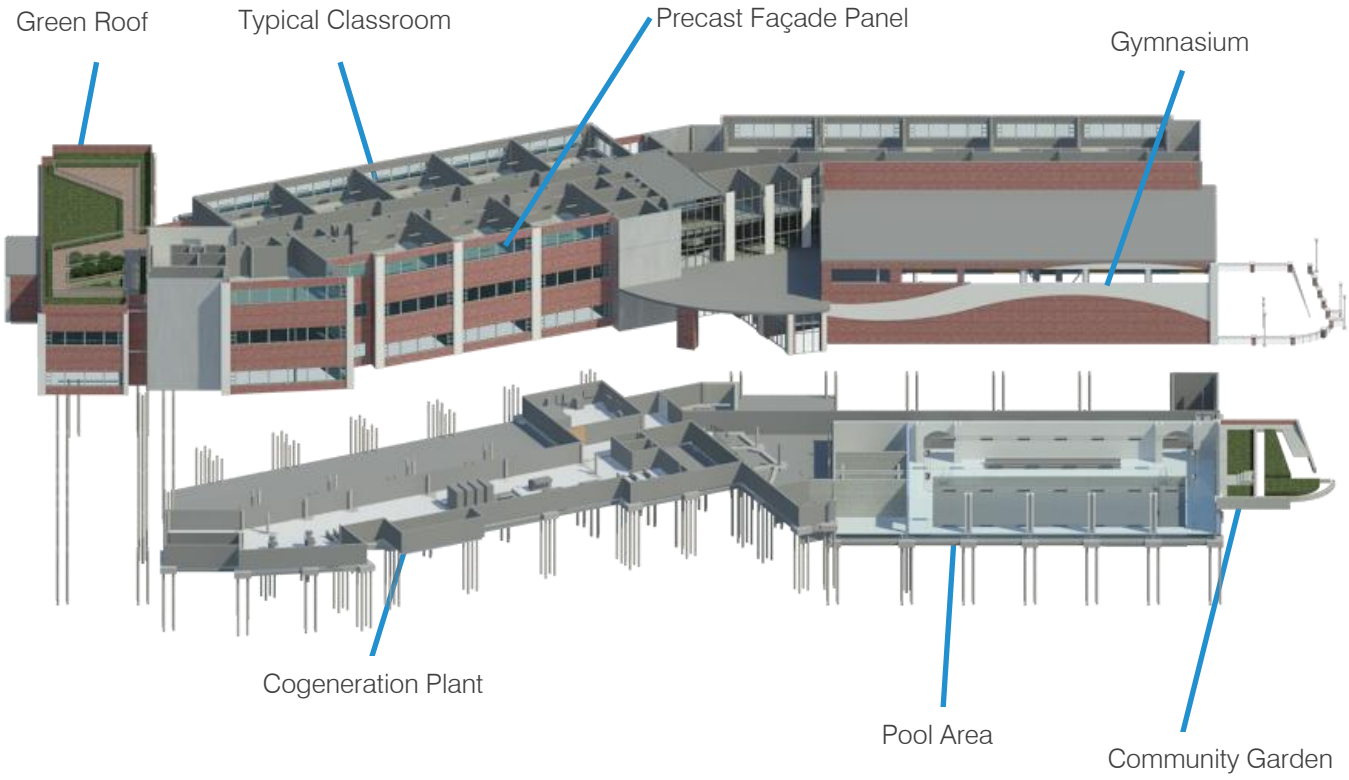


Figure 4: Site Plan of the New Reading Elementary School

Conveniently, the school location also takes advantage of adjacent educational facilities. Existent at two of the other corners of the site intersection are another Reading School District elementary school and Albright College. Albright College offers Elementary Education as a major field of study. The new elementary school could coordinate with that collegiate department for student teaching, as well as provide both sets of students with cross-generational learning opportunities; thus furthering the building's identity as an integrated community facility.

Building Layout

The Reading Elementary School consists of many areas which work with each other to produce a school that functions harmoniously and benefits the entire community. In the following section, each critical building area is analyzed from an integrated design standpoint. Figure 5 below shows the overall layout of the school, calling out the areas discussed on the next few pages of this narrative.



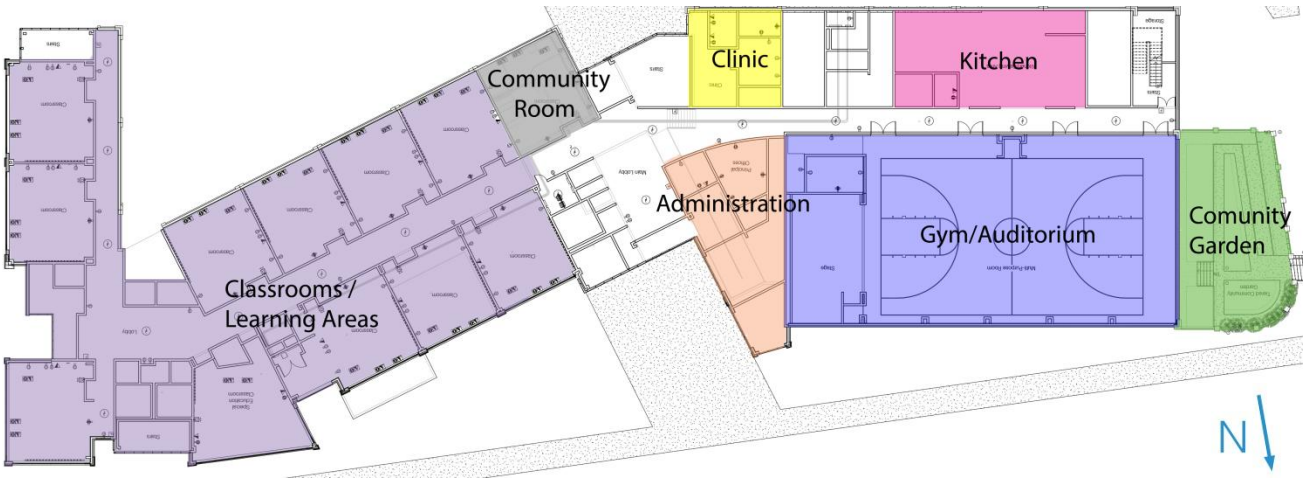


Fig 5: Isometric View and First Floor Plan with the Highlighted Areas

Community Assets

The elementary school boasts many community assets that render the school multi-functional, offering more to the community than just classroom space. The spaces intended for general community use were intentionally grouped in the same wing of the building so the community areas can be isolated physically for security purposes, as well as isolated mechanically to allow the wing to be occupied with minimum operating costs.

Competition Swimming Pool

The competition guidelines state that the school district and city of Reading would like the design team to consider the inclusion of a competition swimming pool in the elementary school design. Integrating a swimming pool into the design supported our project statement of "building a better community" by giving acess to a swimming pool to the surrounding community.

Program space for the community swimming pool was added to the basement level of the school beneath the gymnasium. Adding the swimming pool in this area made sense from a logistical standpoint. This pool location groups all the areas open to the community to the west side of the school on the first and basement floors. At the same time, the pool's basement level location creates complexities with accessibility. To comply with ADA, an elevator is connected to the pool space through a newly designed hallway in the basement level.

Shown in Figure 6 on the next page, a unique aesthetic is established through exposed structural, mechanical, and lighting systems that seamlessly integrate with long span cellular beams. Cellular beams control vibrations from the gymnasium above, while stretching across a 60-foot span and offering 24-inch diameter spaces for duct and sprinkler runs. Refer to page 10 of the Structural Narrative to read more about the cellular beam design and corrosion control plan.

Figure 6: Rendering of Pool Systems Integration

Although we have presented an alternative design that does not include a pool, the design team strongly encourages the integrated pool design. Inclusion of the basement pool opened up some unique design opportunities and in some cases, helped solve some issues.

- Inclusion of the swimming pool presented a significant year-round heating load (see Mechanical Narrative for description). Exhaust heat from the designed combined heat and power (CHP) system will be used to heat the pool and other building heating loads, resulting in high energy savings.

- The pool will require more excavation in the basement level, which will reduce the risk of future sinkholes.
- With the pool integrated into the building footprint, more space can be used on the site for athletic fields, playgrounds, and parking.
- Community garden (described next) is built into the pool excavation area to allow light into the pool space.

Should the Reading School District decide to forgo the swimming pool and/or combined heat and power (CHP) system, the design team is proposing the following options, formatted in Figure 7. The decision to waive the pool design must be made by March 1, 2013 (3 months prior to construction) to have no impact on the project schedule. In this event, there will be no excavation under the gym area, causing the west wing of the school to be on grade.

Figure 7: Alternative Design Options for Pool and CHP system

	Base Design – Integrated Pool and CHP Design	Option – No pool, Yes on CHP system	Option – No pool, No CHP system
Integrated Pool?	Yes	No	No
CHP system?	Yes	Yes	No
Cost	Baseline Cost	Credit of $2,300,000	Credit of $2,315,000
Comments	Most integrated design choice. Full reported savings from CHP system. Gives community access to swimming pool without increasing the building footprint.	Exhaust heat from the CHP system can be redirected to existing school on site. Full savings from the CHP system will be spread out over the newly built school and existing elementary school. School district has the option to build an above ground pool in the future. The community garden is still inclusive as part of the base contract.	Mechanical equipment (boilers, pumps, etc.) is already designed to handle school loads without operation of CHP system. Thus, full mechanical redesign is not necessary. Only a few changes in basement mechanical room layout will take place. CHP system savings will be lost with this option and a generator will be necessary.

Community Garden

A solution allowing daylight into the pool area was found by including a tiered community garden adjacent to the west façade of the school. The finished site will be excavated in levels, finishing with its lowest elevation against the building. The tiers of the terrace will be finished with plant boxes for the community garden. A 3D view of this community garden is shown in Figure 8. The school can either allocate space in this community garden to the public, or assign the space for classes in the elementary school to maintain.

Fig 8: Tiered Community Garden Rendering

In addition to the allowed natural light from the community garden, the glazing provides an unobstructed view of the competition pool space.

Gymnasium / Multipurpose Space

The gymnasium will be an important part of the community. In addition to hosting basketball and other sporting events, the gym will be used as a shelter that covers natural disasters such as hurricanes. The designed combined heat and power system will be able to provide both emergency electric power and heat to the space in the event of a downed electric grid. Figure 9 shows a rendering of the multipurpose gymnasium.

Acoustical considerations were taken with respect to the gymnasium space. Noise coming from this space is expected to be loud as the gymnasium will also be used for multipurpose such as cafeteria space. Acoustical decking was used in the ceiling of the gymnasium, and the mechanical duct system was isolated from the rest of the school.

Fig 9: Gymnasium Rendering

Learning Areas and Classrooms

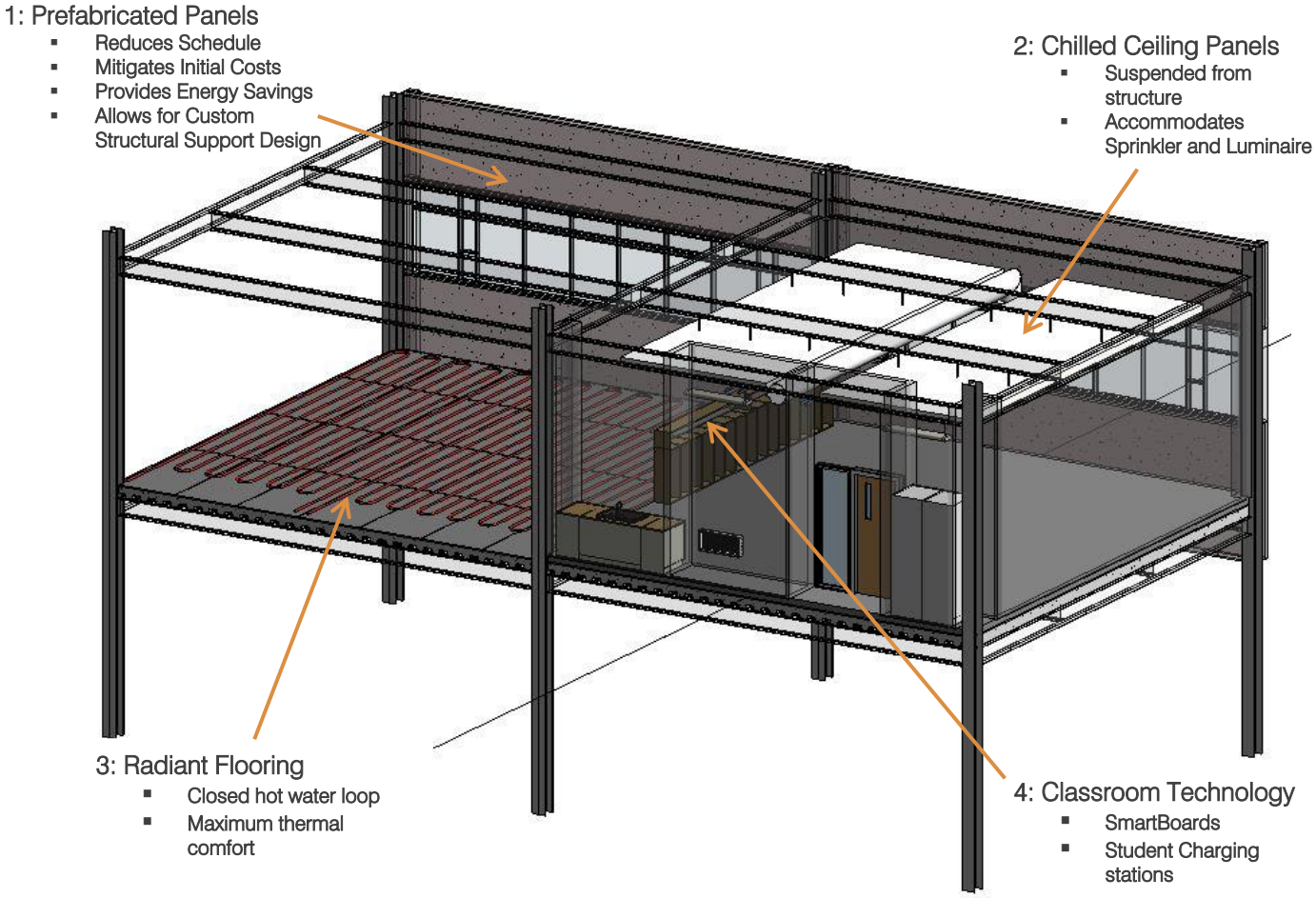


Fig 10: Two Adjacent Classrooms Showing System Assemblies

An innovative learning space is essential to improving the Reading School District. Our proposed design offers a space that not only houses rooms for education, but rather actively *helps* the students learn. Attention was given to details that would improve the functionality of the educational spaces. The indoor environmental quality enhancement provided our team many opportunities for integration. At the same time, proper integration was required for our team to ensure construction accuracy of our non-traditional systems. A 3D mockup of a typical classroom was constructed for system verification. Shown previously in Figure 10 is a screenshot of our 3D classroom model. The mockup was also used to visually test the sequence of construction via 4D modeling for the team to review. All major engineering systems were included in the mockup.

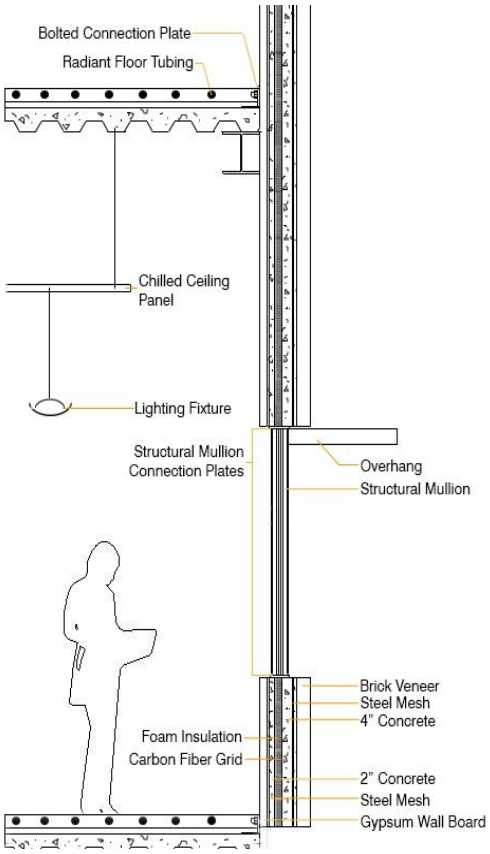


Fig 11: Detailed Section of Prefabricated Panel

Fig 12: Exterior View of Panel Assembly with Overhangs

1: Prefabricated Panels

The design team had the desire to keep a lean building schedule and mitigate costs when it came to the selection of a façade system. The use of prefabricated panels for the façade reduces schedule time by 45 days. The panels also reduce air leakage with continuous insulation provided throughout each one. This reduction saves $2,000 to $3,000 per year; relieving an additional initial cost of $25,000 in 10 years. This can be seen on page 4 of the Innovative Construction Narrative. Selection of our customizable panels produced structural design issues that are not common of a typical building envelope. The solution to how the panels would be structurally supported included the design of connection plates cast in with the inner 4" layer of concrete in the panel. This allows for bolted connections to the building's steel frame as seen in Figure 11. To make the exterior wall a complete system once installed, welding plates mounted at the top and/or bottom of the panels provide a connection for structural mullions, easing window installation. More detailed information on the prefabricated façade panels are found on page 11 of the Structural Narrative.

Inclusion of the overhang as seen in Figure 12 will be installed on site provides the necessary passive lighting levels.

2 & 3: Chilled Ceiling Panels & Radiant Flooring

Prior to final selection of the classroom HVAC systems, criterion relating to integration capabilities, versatility and environmental health fueled the team's research into which systems will go above and beyond industry standards during operation. The inclusion of passive chilled ceiling panels that cool the 100% outdoor air supplied at constant volume were chosen for their ability to integrate the sprinkler and lighting fixtures. Specified panels include structural frames which allow for luminaires and sprinkler heads to be hung from them without degrading their integrity and voiding any warranties. The radiant chilled ceiling panels cover 70% of the room area, giving the lighting a flat, white surface to reflect light indirectly into the learning space.

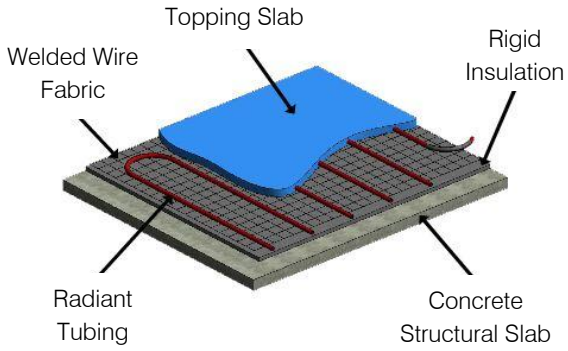


Fig 13: Radiant Flooring Slab Mockup

A radiant flooring system will be used for space heating. It was determined that using this system increases structural loads by only a minimal amount, thus having little effect on member sizing. The lighting and electrical systems are not affected by this system either. However, construction quality of the radiant floor system needed to be addressed to avoid future problems with the system. The team made an even more focused 3D mockup of the radiant flooring system complete with the structural support to plan installation methods of this system before construction starts.

Figure 13 shows the 3D mockup of the radiant flooring system. The piping and welded wire fabric will be preassembled and delivered to the site in large rolls. Each roll will be the size of one classroom, and installation of the system will simply require rolling the fabric/pipe combination over the rigid insulation. The piping loop will be pressure tested to ensure no leakage before the topping slab is placed.

4: Classroom Technologies

With Reading, PA being an economically challenged city, the group wanted the elementary school to be able to accommodate current and future technological advancements. The proper use of technology can enhance the learning environment and keep students excited about coming to school every day.

Classrooms will include interactive whiteboards and multi-use operational controls which allow teachers to control the indoor environment of the space. The radiant heating and cooling systems installed in the classrooms are operated from individual thermostats in each classroom, allowing teachers to set the room for optimal thermal comfort.

To account for any technologies that the school board may introduce as part of the learning curriculum, the design team decided to add charging stations above every student cubby to charge hand held and portable devices. The use of these stations allows for a single classroom to have access to literature, images, and instructional programs via portable technology. Every classroom can become its own library since the source of electronic material will always be accessible. Doing this is a way the project team is planning for the future of technology usage by students and in schools.

Security

In light of the recent events, including the tragedy that occurred at the Sandy Hook Elementary School in Newtown, CT, our team considered new approaches to student security. The following sections highlight the main points of our security features and a full detailed security plan can be found on Drawing Integration-8.

Building Access

Access (or preventing access) to the interior of the school is the key to our team's security strategy. The only door which will be operable from the outside during the school day is the main vestibule entrance. All other exterior doors will be locked during school hours. In order to prevent a possible intrusion, all exterior doors will include ballistic glass to increase security. The team reviewed possible ways a threat could enter the building and addressed concerns to occupant safety. While the security strategy shown in Figure 14 on the following page does not perfectly secure the building, a tradeoff had to be made with cost and functionality. Our team believes that this strategy can effectively prevent many of the potential threats from entering the building, without turning the school into a lock-down prison. It was rather helpful to align each entry point and solution in a diagram flow chart:

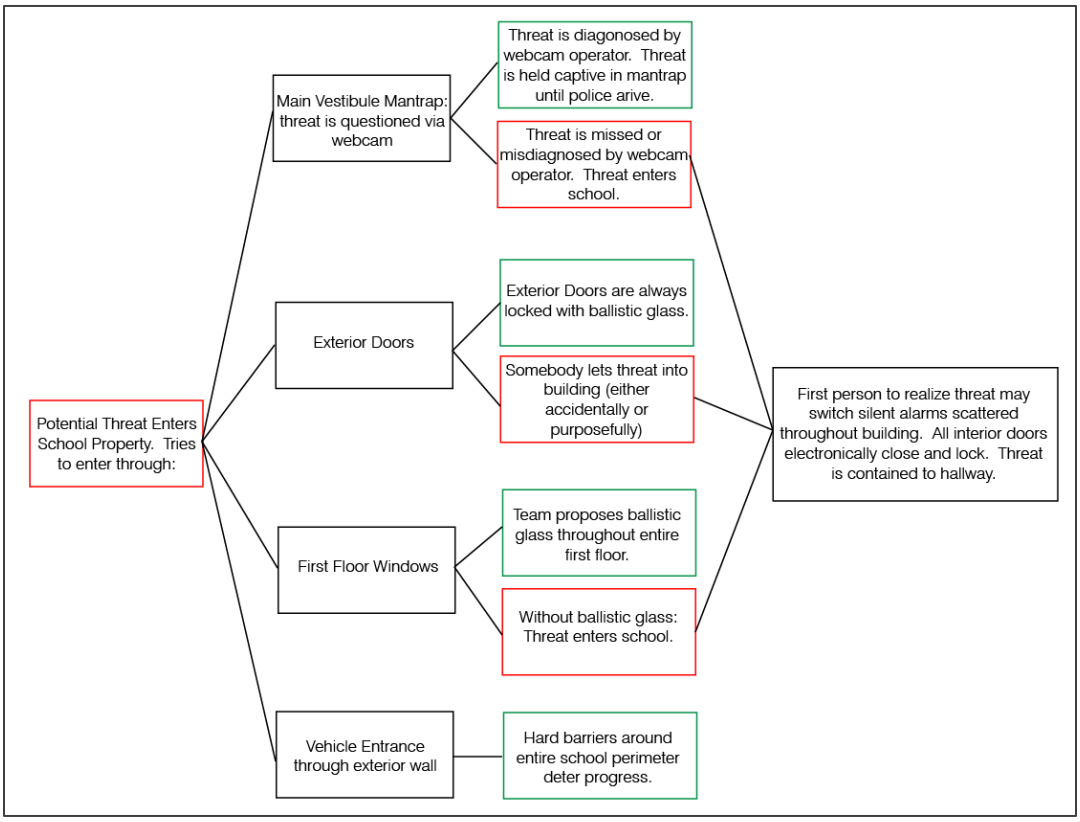


Fig 14: Strategic Security Web Diagram

Mantrap

To prevent intrusion through the main entrance vestibule or an ambush to the reception area, a mantrap will be used. Figure 15 highlights the mantrap design. When a visitor enters the vestibule, the door will lock behind them and they will speak to the receptionist in the office via video screen. There will be a slot in the reception door to provide credentials such as identification. Once verified as safe, the receptionist will electronically release door locks to either the lobby or reception area, depending on the nature of visit. Should the visitor be deemed unsafe, they will remain trapped in the blast-proof vestibule until police arrive. Visitors without credentials may be told to leave without being trapped.

Ballistic Glass Alternate

As stated above in the flow chart diagram, the project team is proposing the substitution of ballistic glass in lieu of regular window glass in the entire first floor for a cost of $86,250. The ballistic glass on the first floor will prevent threats from entering via the first story windows and protect the building from nearby drive-by shootings, which have occurred in Reading in the past. It is important to note that this approach was used at the newly renovated Citadel High School in Reading for the same purpose.

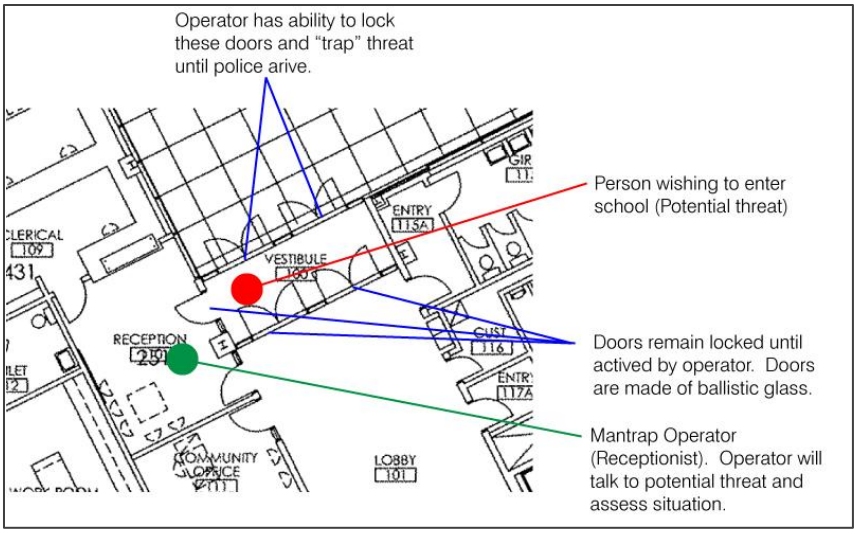


Fig 15: Mantrap Diagram

Virtual Design Review

Fig 16: Expert Virtual Design Review

In order to determine the effectiveness of the project team's design, it was decided to create a detailed classroom model using the Unity 3D software package. A university educational department head with a Master's and Doctorate degree in Education and a current sophomore working toward her Bachelor's degree in Early Education took time to evaluate the overall design in a review session with our team. The goal of the session was not focused around the team's design needs but rather around the overall improvement of learning spaces and how they will serve the school district. Figure 16 to the left shows the design review in action.

Using a 3D immersive lab, the team collaborated with the design reviewers to figure out what was appealing about these spaces and what should be improved. The team gave full control of the session to the reviewers once a quick tutorial on program navigation was given. This allowed our volunteers to give crucial feedback without any inhibitions. During the process, the team asked open ended questions on items such as desk selection and what makes the space conducive towards optimal learning. Questions like these lead to answers that gave us insight into ideas such as accommodating for mobile desks so students can form groups or "pods".

A SmartBoard projecting a plan of typical learning spaces was also provided. The inclusion of the SmartBoard session allowed the design team to fully comprehend and visualize input from the reviewers that may otherwise have been difficult for them to convey. Figure 17 to the right shows the reviewers using the SmartBoard technology.

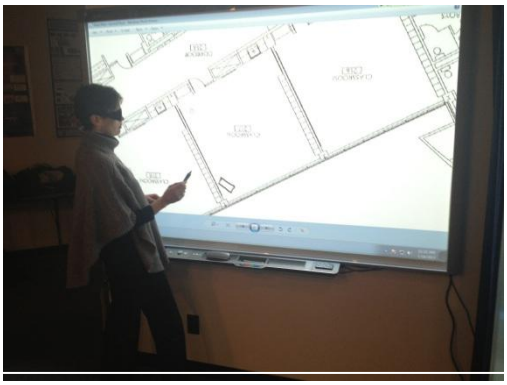


Fig 17: Interactive SmartBoard Session with Expert

The team followed up the review with a post-meeting to discuss improvements to the design as a result of the advice and critiques that were given. Through these comments, we were able to get a better understanding of the preferred classroom layout such as number of computers, outlets, and desks grouped together. Furthermore we were able to gain an understanding of the quality and quantity of security measures teachers would need to feel safe in an inner-city setting. By performing the virtual review we were able to mitigate the risk for costly future changes to the school by making the necessary changes at a more ideal phase in our design process.

Building Information Modeling

The industry of architectural engineering is steadily moving towards the use of technology for aid in design and construction. BIM, which is the epitome of this, is defined as the process involving the generation and management of digital representations of physical and functional characteristics of a facility. The transition from the older means of design to the paperless world requires the utmost amount of care and attention to detail.

At the earliest stages of our design process, every discipline created their respective models utilizing Revit 2013 and its collaboration features as the team's main hub for modeling and integration. This made it possible to extract information for further use in more technical analysis programs such as Autodesk Navisworks which was used during construction of the model by the construction management team for interdisciplinary clash detection and construction sequencing. This program was also used to create a 4D model to demonstrate phasing of construction. The Revit model was also exported to RAM Structural Systems and Autodesk Green Building Studio. RAM assisted the structural team in designing the lateral and gravity members of the building while Green Building Studio supplied

information such as water consumption to the mechanical team. Information from our virtual building such as dimensions, device quantities, material properties, and distribution lengths were used to contribute to SKM PowerTools, AGI, and Daysim models for analysis by the Lighting and Electrical team. The team decided at the beginning of the project that modeling everything was not practical or beneficial. As exemplified by Figure 18, it was determined that the entire structure, all ductwork, main plumbing runs and 3" electrical conduit or greater would need to be modeled for coordination purposes.

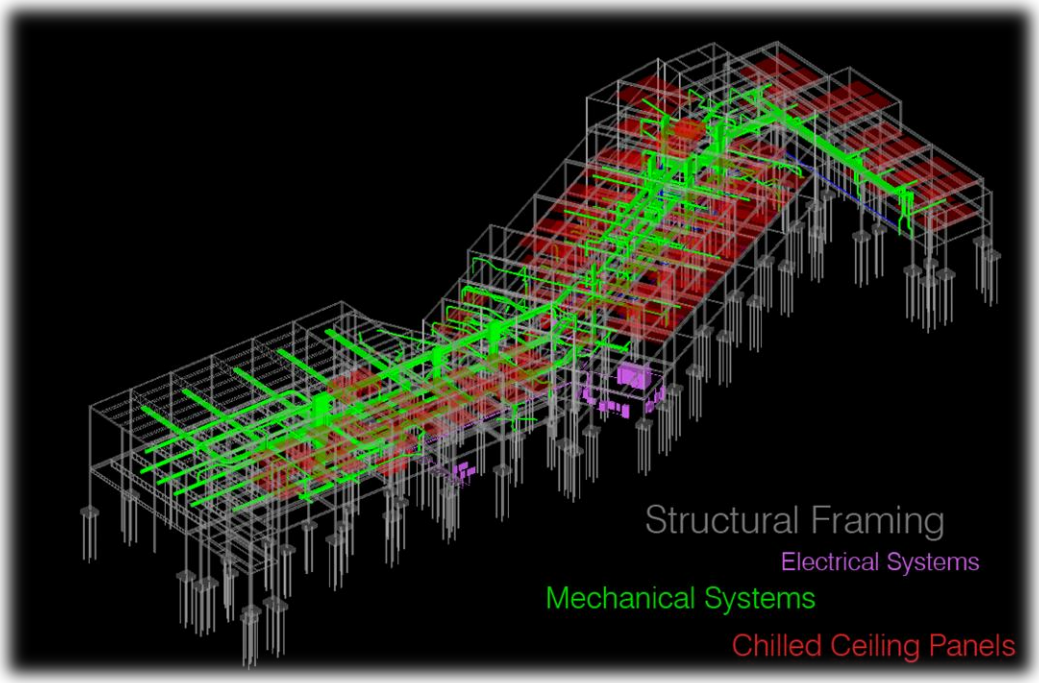


Fig 18: Expert Virtual Design Review

Our team approached our design process using "The Big Room Idea" which involved everyone working within relatively close proximity to each other. This allowed everyone to be available for project input at a moment's notice when needed and also allowed for the use of a SmartBoard to sketch ideas or solutions during discussions. Furthermore, face-to-face meetings allowed greater interdisciplinary interaction on important issues such as the prefabricated panels and system layout and equipment location. By addressing these coordination concerns during the design, it reduced the need for rework in the final stages of design.

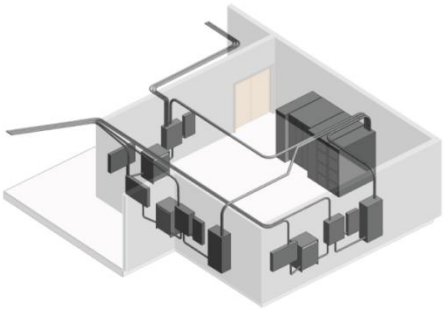


Fig 19: Electrical Room Layout

Each decision had the potential to impact the design as well as many other aspects of building. One example includes the mechanical system we selected. Since there are smaller duct requirements and larger piping requirements, the extra space in the ceiling plenum allowed for simpler system coordination. The system layouts and equipment locations involved all disciplines in order to determine a solution with the least negative impact and benefit the project overall. The benefit of using a coordinated decision approach resulted in the location of all of the major building equipment as well as the overall design of the mechanical and electrical rooms which can be seen in Figure 19.

The design process using a high level of coordination proved to be very successful seeing as there were zero clashes between our major systems mentioned above. The team understood that the branch conduit and piping could have heavily affected the clash detection, but due to smaller size and adaptability of these items, they are more easily adjusted during construction.

Conclusion

To conclude this integration report, our team would like to take a step back and open a discussion on how the integrated building design approach used in this competition meets the mission of the Charles Pankow Foundation of providing the public with more efficient and effective building design strategies. The integrated design allowed our team members to view the challenge from a holistic setting from the very start of the project, and apply engineering solutions to many of the design problems inherent in the competition.

Despite the fictional competition setting, our team was subjected to many of the issues that arise in real projects that use an integrated design approach. We encountered many instances where team members disagreed on important design decisions (Where to locate the pool, whether or not to include combined heat and power, etc…). What our team took away from these disagreements, however, was that there was not necessarily a "correct" answer to these issues, but rather many solutions that have varying advantages and disadvantages. The way to measure the success of a particular design decision is to look at how much that decision matches with your project goals agreed upon in the beginning stages of design.

Thus, team alignment in the beginning stage of design is perhaps the most important phase of the entire project. Failure to align each member of the team to overall project goals would result in mixed measurements of success. Through our design of the High-Performance Elementary School in Reading, our design team focused on three values:

1. Build a better Reading community through construction and implementation of school and community programs

2. Design the elementary school to high-performance standards

3. Utilize an integrated design approach to maximize quality, efficiency, and value of the final built product

With focus on the above values, our design team has created a school that can serve as a model for the future generations. The enhanced value of the learning space is intended to increase the learning capacity of the students attending the school. Also, a theme of community throughout the school will allow the school to act as a central node in the community. Use of the building beyond an elementary school will ensure the success of the building, and will result in lasting benefits.

Despite the current state of the Reading community, our design team believes there is hope for the next generation of the community. The ASCE Charles Pankow Foundation Student Competition provided our design team the opportunity to shape the future of that next generation. With an innovative, high-performance elementary school, our design team hopes to educate and inspire the students that will attend the school. The competition provided us the opportunity to capture the waiting potential that Mayor Spencer believes lies in waiting:

"In the middle of every difficulty lies opportunity."

Vaughn D. Spencer, Mayor of Reading, Pennsylvania

Integration Supporting Documentation

ASCE Charles Pankow Foundation Architectural Engineering Student Competition

Team Registration Number **05-2013**

Our team submitted designs in the following categories:

Building Integration Design
Structural Systems
Mechanical Systems
Lighting/Electrical Systems
Innovative Construction Management and Construction Methods

Supporting Documentation

Table of Contents

Drawings

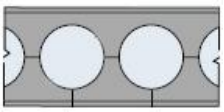
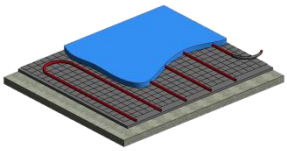
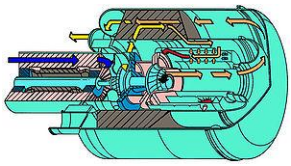
Competition Goals and Challenges

In accordance with Charles Pankow's principle of "Thinking Beyond the Building," our team thought beyond the goals of the design competition by establishing team integration goals in response to the Pankow goals and challenges. The information below summarizes our team's response to these goals.

Pankow Goals

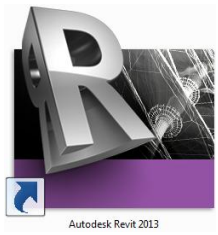
1. Improve the quality, efficiency, and value of large buildings by advancing innovations in structural components and systems that can be codified.

INNOVATIVE SOLUTIONS

Construction Management	Structural	Mechanical	Lighting/Electrical
			
Augmented Reality *Interactive use of 3D site logistics plan eases coordination*	Cellular Beams *Long span beams ease system integration*	DV/CC System *Air quality and thermal comfort improved while saving energy*	Microturbine *Onsite energy production alleviates dependency on grid*[1]
QUALITY	QUALITY	EFFICIENCY	VALUE

2. Improve the performance of building design and construction teams by advancing integration, collaboration, communication, and efficiency through innovative new tools and technologies, and by advancing new means and methods for project team practices.

COLLABORATION TOOLS AND TECHNOLOGIES

BIM Execution Plan	Revit 2013	Unity 3D	Interactive Whiteboard
			
Strict design schedules improve team meeting efficiency and ensure consistent workflow	*Clash detection capabilities ease system integration and foresee contractibility issues*	*Virtual design review allows occupants to experience their future space firsthand*	*Team meetings dependent on interactive whiteboard enhance design review*[2]
EFFICIENCY	INTEGRATION	COLLABORATION	COMMUNICATION

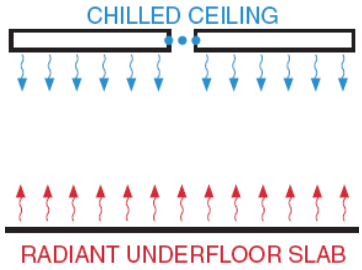
[1] http://upload.wikimedia.org/wikipedia/commons/thumb/1/1b/GasTurbine.jpg/300px-GasTurbine.jpg
[2] http://www.interactiveclassroomsolutions.ie/images/interactive-whiteboards-s2.jpg

Design Competition Challenges

1. Address construction and design issues related to a high performance building that meet the needs of both the school district and community.

HIGH PERFORMANCE CONSIDERATIONS

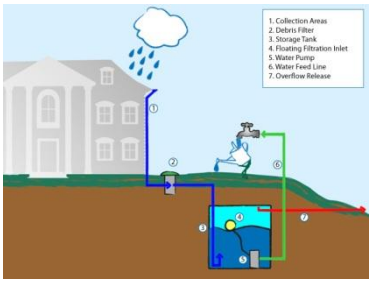
Water-Based Heating & Cooling



Reduces energy consumption and peak power demand, as compared to an air-based system

ENERGY CONSERVATION

Rainwater Collection System



Rainwater collection system reduces storm water runoff, making the building sensitive to the environment[3]

ENVIRONMENT

Mantrap

Mantrap confines potential threat to secure and transparent location, securing the remainder of the facility

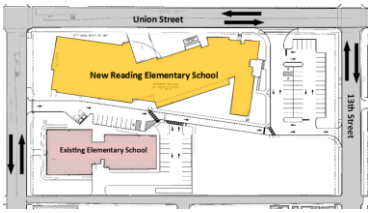
SAFETY & SECURITY

Brick Façade Paneling

Precast façade panel surpasses durability of hand-laid brick, while reducing construction time

DURABILITY

Intersection of 13th & Union St



Building set in central location, within walking distance of Albright College and a popular suburban neighborhood

ACCESSIBILITY

3.4 Year Payback

Microturbine Cost (http://www.wbdg.org/resources/microturbines.php)		
300 kW		
Category	Avg. $/kW	Cost
Initial Cost	$900	$270,000
Heat Recovery	$213	$63,750
Total Equip. Cost		$333,750
Installation (% of others)	40%	$133,500
Microturbine Installed Cost		$467,250
Avoided Generator Cost		-$200,000
Energy Grant		-$250,000
Total Initial Cost		$17,250
Yearly Maintenance (kWh)	$0.0105	$10,500
*estimate 1,000,000 kWh/year		
Avoided Generator Cost ($/yr)		-$2,000
For 20 Year Life		$170,000
System Life Cycle Cost		$187,250
Yearly Energy Savings		$56,125
Payback Period (years)		3.34

With the benefit of an energy grant, the building's microturbines uphold a payback period of 3.4 years[4]

COST-BENEFIT

Improved Indoor Air Quality

DOAS system provides improved indoor air quality, which is linked to better student test scores[5]

PRODUCTIVITY

Green Roof

Green roof minimizes heat gain through roof, while also performing as an alternate learning environment

SUSTAINABILITY

Microturbines

Microturbines remotely monitored by the manufacturer, eliminating the need to hire trained professionals[6]

OPERATIONS

[3] Rainwater Systems. 2013. EcoVIE, Atlanta. Web. 14 Feb 2013.
[4] Refer to Page 8 of Construction Submittal for full size image
[5] 2011 Strategic Plan. 2011. Reading School District, Reading. Web. 14 Feb 2013.
[6] Microturbines_1. 2013. Capstone Turbine Corporation, Chatsworth. Web. 14 Feb 2013.

2. Achieve LEED certification under the LEED 2009 for Schools New Construction and Major Renovations.

The proposed design is applying for LEED Gold certification under the LEED 2009 for Schools New Construction and Major Renovations. Below is a checklist of anticipated points under that LEED program.

Sustainable Sites 15 / 24

While the building site posed challenges to our team with respect to construction logistics and security, the urban setting of the site allowed us to claim many of the credits in the Sustainable Sites category. The proposed green roof, rainwater collection, and local vegetation plan also helped us claim credits in this category.

Credit 1	Site Selection	1 Point
Credit 2	Development Density and Community Connectivity	4 Points
Credit 3	Brownfield Redevelopment	1 Point
Credit 4.1	Alternative Transportation – Public Transportation Access	4 Points
Credit 4.2	Alternative Transportation – Bicycle Storage and Changing Rooms	1 Point
Credit 6.1	Stormwater Design – Quantity Control	1 Point
Credit 6.2	Stormwater Design – Quality Control	1 Point
Credit 7.2	Heat Island Effect – Roof	1 Point
Credit 10	Joint Use of Facilities	1 Point

Water Efficiency 8/11

The points claimed in the Water Efficiency section are due to the green roof, rainwater collection, and low-flow plumbing fixtures designed in our school.

Credit 1	Water Efficient Landscaping Option 2	4 Points
Credit 2	Innovative Wastewater Technologies	2 Points
Credit 3	Water Use Reduction – 30% Reduction	2 Points

Energy and Atmosphere 15/33

The majority of the points we are claiming in Energy and Atmosphere stem from the efficiencies of our system and equipment selection, as well as our cogeneration plant. A commissioning plan will also be established to claim the points in Enhanced Commissioning and Measurement and Verification.

Credit 1	Optimize Energy Performance – 30% Improvement	10 Points
Credit 3	Enhanced Commissioning	2 Points
Credit 4	Enhanced Refrigerant Management	1 Point
Credit 5	Measurement and Verification	2 Points

Materials and Resources 5/13

An enhanced construction waste recycling plan and use of recycled and local materials constitute the Materials and Resources credits we plan to achieve.

Credit 2	Construction Waste Management – 50% Recycled or Salvaged	1 Point
Credit 4	Recycled Content – 10% of Content	1 Point
Credit 5	Regional Materials – 20% of Materials	2 Points
Credit 7	Certified Wood	1 Point

Indoor Environmental Quality 16/19

Indoor Environmental Quality was a large factor in our design. Many of the points in this category are claimed from the unique and innovative methods of ventilation and conditioning.

Credit 2	Increased Ventilation	1 Point
Credit 3.1	Construction IAQ Management Plan – During Construction	1 Point
Credit 4	Low-Emitting Materials	4 Points
Credit 5	Indoor Chemical and Pollutant Source Control	1 Point
Credit 6.1	Controllability of Systems – Lighting	1 Point
Credit 6.2	Controllability of Systems – Thermal Comfort	1 Point
Credit 7.1	Thermal Comfort – Design	1 Point
Credit 7.2	Thermal Comfort – Verification	1 Point
Credit 8.1	Daylight and Views – Daylight – 90% of Classrooms	2 Points
Credit 9	Enhanced Acoustical Performance	1 Point
Credit 10	Mold Prevention	1 Point

Innovation and Design Process 2/6

Our team will be applying for an innovation in design through use of the cogeneration plant. We are claiming that the waste heat from the cogeneration plant will be able to heat the pool, the largest energy consumer in our building.

Credit 1.1	Innovation in Design: Efficient Pool Heating Strategy	1 Point
Credit 3	The School as a Teaching Tool	1 Point

3. Provide a budget for the school district for the design and construction of the project focusing on both the short term and lifetime cost-benefits of the design solution.

Short Term Benefits	Lifetime Cost Benefits
Integrated pool saves $510,825 over a separate building design	Façade panels and radiant mechanical system greatly decrease maintenance costs
General conditions costs are lessened by a shorter project schedule	All additional initial costs have payback periods under 10 years
School price is $2,396 per student under the national average	Façade panels save $2,000-$3,000 yearly due to low air leakage
	Radiant mechanical system saves $22,000 per year in energy
	The CHP system saves the school district $56,125 yearly in energy

Meeting Minutes

The following excel sheet was used during our team meetings to keep the meetings organized, and divide tasks. The excel sheet for each meeting was saved in a common drive folder so that all team members could easily refer back to discussed topics. Items highlighted green indicate an issue that was resolved, while yellow indicates an issue that still has yet to be resolved. Items highlighted in red (not shown in this example) are for items that need to be resolved immediately.

KEY: RED - Date for resolution critical YELLOW - Resolution critical within 2 weeks GREEN - Resolution req'd but not critical GREY - Issue Closed

LINE ITEM	ISSUE #	Sched. Priority	DESCRIPTION	Category	RESP. FIRM	RESP. PARTY	DATE ID.	ORIG. DATE REQ'D	REVISED REQ'D DATE	DATE CLOSED	COMMENTS
2	9	0.2	Pool	General	All	All	20-Sep	Ongoing			**10/11** – No change. **9/27 and 10/4** – Presentation working session and no meeting. During the weeks, a general floor plan and depths for the pool have been decided. The community garden area has also been modeled. **9/20** – Pool decision has been made. There will be a pool under the gym. Commencing design of this space is crucial. Refer to "Pool Decision Matrix"
4	11	0.3	Façade	General	All	All	20-Sep	Ongoing			**10/11** – The general classroom, gym and stairwell facade design has been determined and will be modeled. **9/27 and 10/4** – Presentation working session and no meeting. General facade panel design and constructibility have been discussed. **9/20** – Precast façade design must be determined ASAP. Keith's girlfriend (Amanda? Sorry man I forget her name) may be "subcontracted"
3	10	0.4	Raised Floor	General	All	All	20-Sep	Ongoing		10/11/2012	**10/11** – It has been decided to go with a radient heating system as opposed to raised floor in order to reduce maintenance costs and be more constructable. Closed Item. **9/27 and 10/4** – Presentation working session and no meeting. Decision to be made 10/11.
1	8	1	3D Model	General	All	All	31-Aug	Ongoing			**10/11** – Continuing progress. **9/27 and 10/4** – Presentation working session and no meeting. **9/20** – Design changes must be finalixzed and put into the current model for the upcoming presentation
6	3	1.2	Schedule	General	All	All	29-Aug	Ongoing			**10/11** – Presentation 3 on 10/24 **9/27 and 10/4** – Presentation working session and no meeting. Presentation comments were sent out by Dan for review
5	3	2	LEED	General	All	All	20-Sep	Ongoing			**10/11** – No change. **9/27 and 10/4** – Presentation working session and no meeting. **9/20** – The predetermination of possible LEED points needs to be discussed to narrow down which ones are possible for the project.
8	6	5	Web Pages	General	All	Dan McGee	29-Aug				**10/11** – No change. **9/27 and 10/4** – Presentation working session and no meeting.

BIM Execution Plan

Our team used the Computer Integrated Construction (CIC) Research Program's BIM Planning Guide, also known as the 'BIM Execution Plan', for team alignment. Excerpts from our completed BIM execution plan are on the following pages.

The BIM Execution Plan created the framework for design process documentation. By documenting our decisions, the team was able to analyze the decisions from the perspective of our goals. Refer to Drawings "Integration-9" and "Integration-10" to view these decision flow charts.

BIM Goals

The team determined from an early stage of design that the use of technology and BIM could provide great assistance in many aspects of an integrated design. In order to determine how to use BIM for this design the team had to determine what the goals were for this project. Based on the goals, potential BIM uses were discussed and included in the char below.

PRIORITY	GOAL DESCRIPTION	POTENTIAL BIM USES
High	Focus on the life-cycle cost, while not forgetting the initial cost	Mechanical, Electrical, Energy, Structural Analysis
High	Emphasize versatile spaces	Site Utilization Planning, Construction System Design
Med	Well Documented Project	Design Authoring, Design Review
Med	Coordinate with all trades when focusing on a discipline specific problem	3D Coordination, 4D Phasing, Cost Estimation
Med	Create a building to unite not only the students but the community as well	Design Review, Design Authoring
Med	Provide opportunities for giving back (or making revenue for the communities)	Design Reviews, Construction System Design

BIM Uses

The team also understood that it would be impossible to use all available technologies. A "BIM Uses" chart was developed based on the team's goals. This chart allowed the entire team to have discussion about the cost and benefits of using these BIM technologies on this project. The chart below highlights the most important BIM uses and what the team decided to move forward with.

BIM Use Not Used In Design	BIM Use To Be Used In Design	BIM Use Not Used in Construction	Potential BIM Use in Construction & Operations

X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
	PROGRAMMING	X	DESIGN AUTHORING	X	SITE UTILIZATION PLANNING		BUILDING MAINTENANCE SCHEDULING
	SITE ANALYSIS	X	DESIGN REVIEWS	X	CONSTRUCTION SYSTEM DESIGN		BUILDING SYSTEM ANALYSIS
		X	3D COORDINATION		3D COORDINATION		ASSET MANAGEMENT
		X	STRUCTURAL ANALYSIS		DIGITAL FABRICATION		SPACE MANAGEMENT / TRACKING
		X	LIGHTING ANALYSIS		3D CONTROL AND PLANNING		DISASTER PLANNING
		X	ENERGY ANALYSIS		RECORD MODELING		RECORD MODELING
		X	MECHANICAL ANALYSIS				
			OTHER ENG. ANALYSIS				
			SUSTAINABLITY (LEED) EVALUATION				
			CODE VALIDATION				
	PHASE PLANNING (4D MODELING)	X	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)
	COST ESTIMATION	X	COST ESTIMATION		COST ESTIMATION		COST ESTIMATION
	EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING

File Structure

Below is the team's file structure which was generated based on the project needs. This structure allowed team members to share information in an easy and coordinated manner. By setting this up and considering every aspect of the project it allowed for proper documentation of all research, decisions, and work related to the design.

FILE LOCATION	FILE STRUCTURE / NAME	FILE TYPE	FILE
Network Drive	Project Drive	FOLDER	TEAM
	Analysis	FOLDER	TEAM
	Construction	FOLDER	Construction
	Lighting/Electrical	FOLDER	Lighting/Electrical
	Mechanical	FOLDER	Mechanical
	Structural	FOLDER	Structural
	Codes/Standards	FOLDER	Structural
	Drawings	FOLDER	TEAM
	All Central Files	.RVT	TEAM
	All Recovery Files	.RVT	TEAM
	Images	.PNG	TEAM
	Meetings	FOLDER	Construction
	Meeting Documents	FOLDER	Construction
	Meeting Minutes	FOLDER	Construction
	Presentations	FOLDER	TEAM
	Research	FOLDER	TEAM
	Trash Bin	FOLDER	TEAM

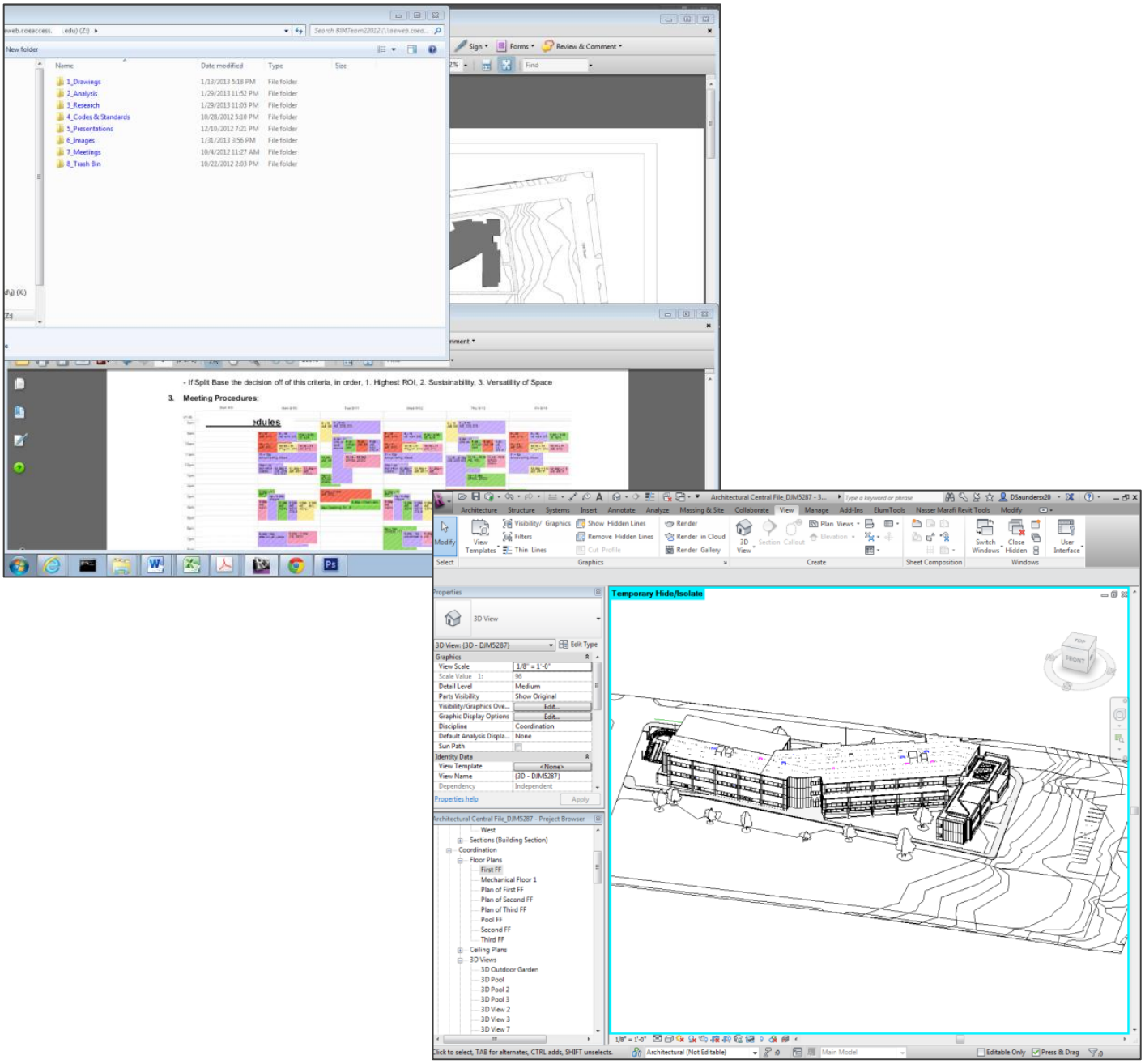
Model Structure

The file names for each model type are determined first by the type of construction, followed by the project name abbreviation as well as the construction team abbreviation. Finally each time the project is saved, the date at the end will be adjusted accordingly to better keep track of the most up to date file.

FILE NAMES FOR MODELS SHOULD BE FORMATTED AS:	
CENTRAL MODEL FILE	Reading Elementary Central File.RVT
ARCHITECTURAL MODEL	Reading Elementary Architectural File.RVT
MECHANICAL MODEL	Reading Elementary Mechanical File. RVT
ELECTRICAL MODEL	Reading Elementary Electrical File. RVT
STRUCTURAL MODEL	Reading Elementary Structural File.RVT

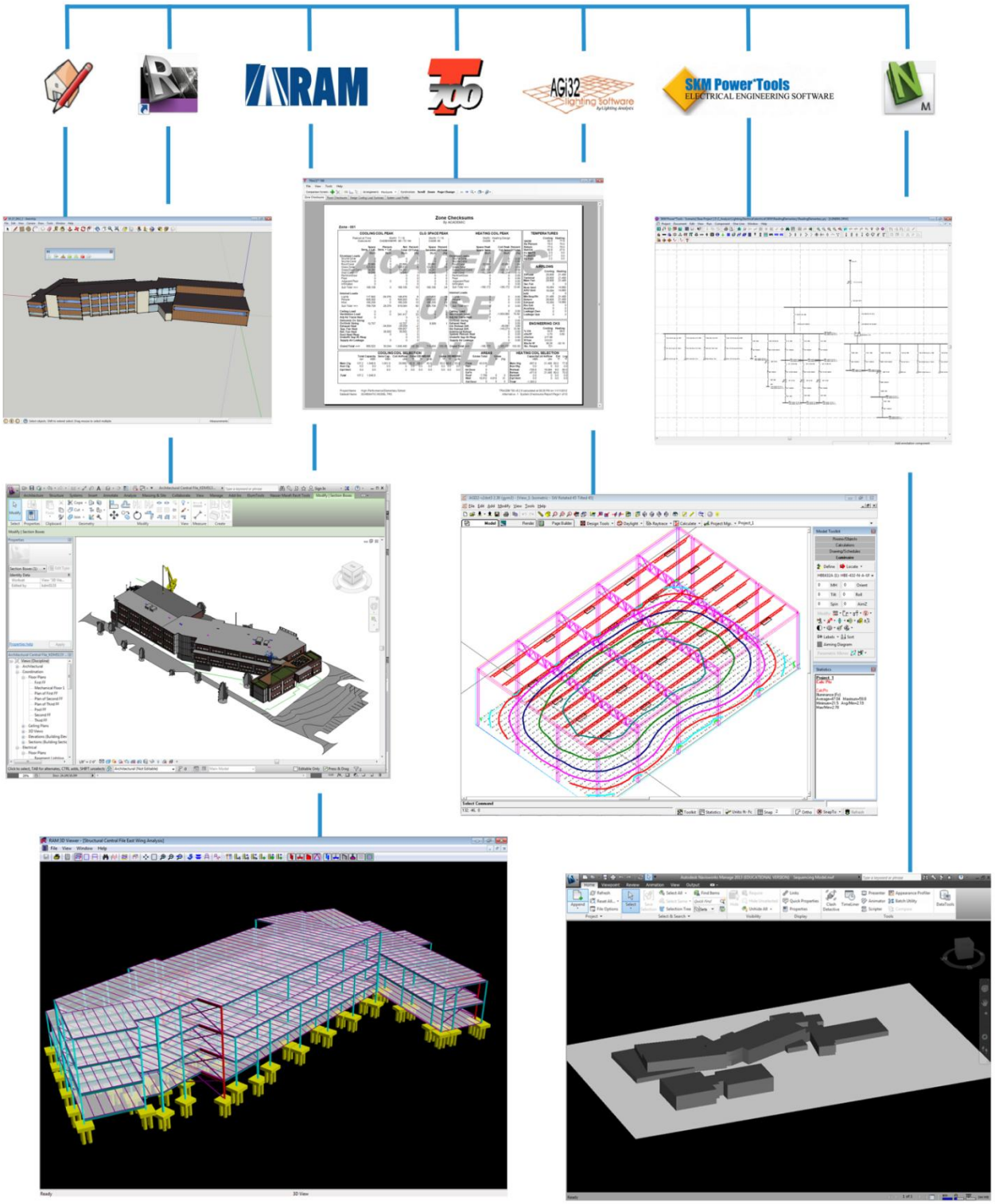
Computer Organization

The image below is a screen-shot of a team member's computer. On the top left, the shared team server folders are shown where all progress was saved. Below the files is a weekly calendar combining all members' class schedules. This allows potential meeting times and availability to be seen easily. The right side of the image is the central Revit file of the Reading Elementary School. Using a central file allows all team members to open local versions to make changes to, and then coordinate with the central. By using this, multiple team members are permitted to work on the Revit model simultaneously and ensure that the main file is the latest version.



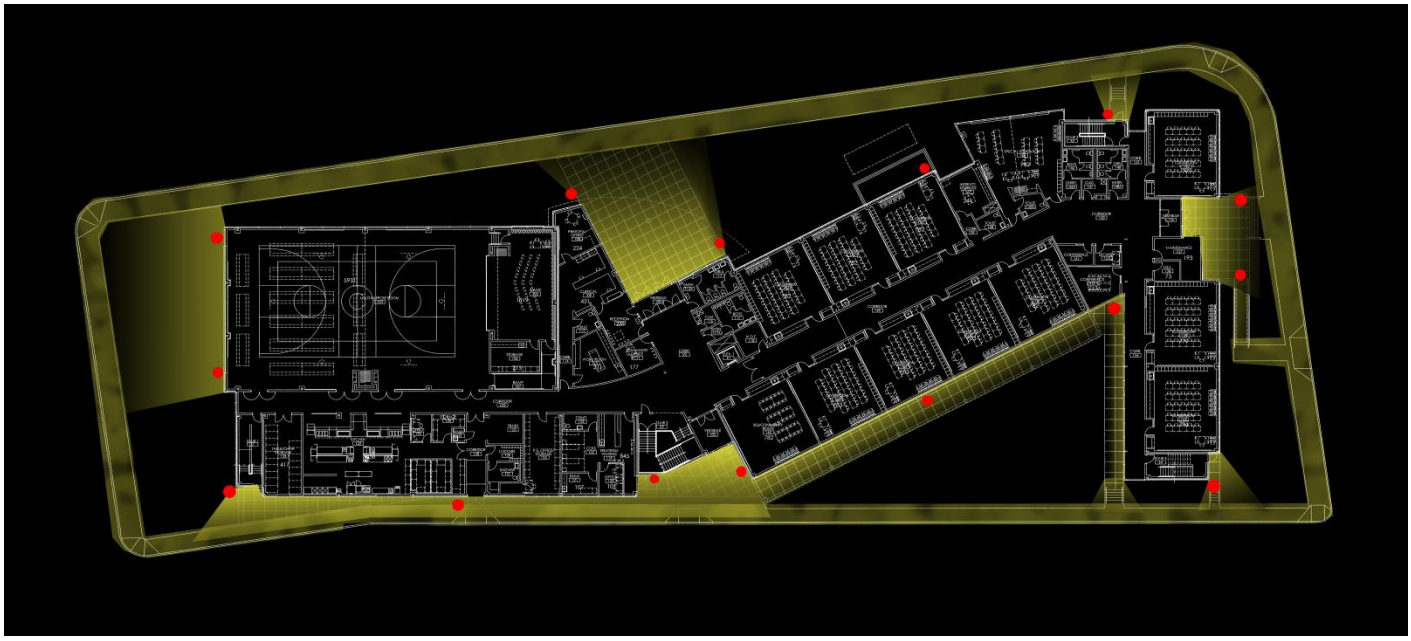
Program Usage Timeline

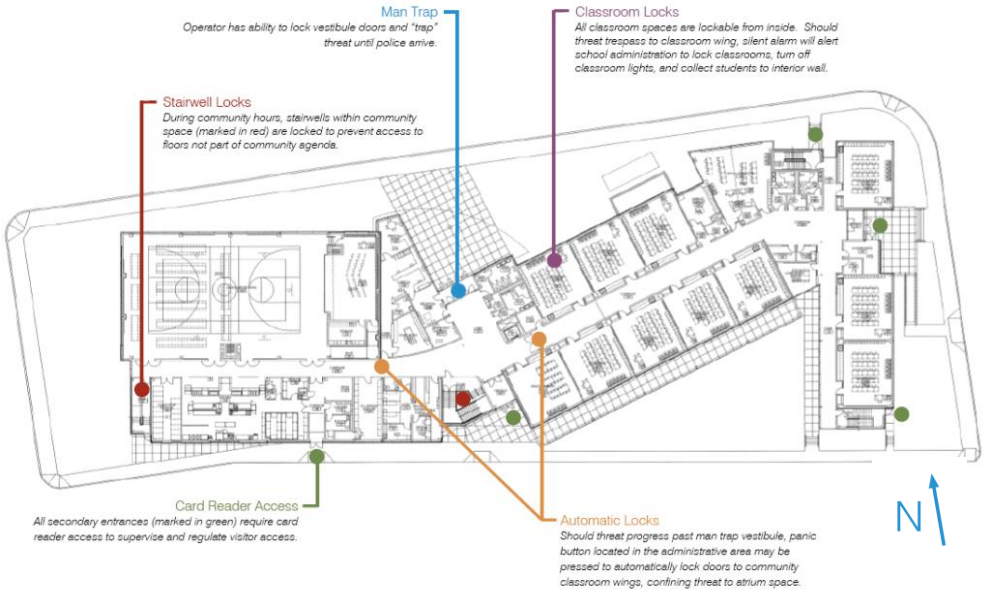
Various software tools were used for collaboration analysis throughout different phases of the integrative process. Below is a timeline showing the different software our team used throughout the design process.



Additional Security Measures

In the below image, the highlights in yellow show a schematic of the exterior building lighting design. It is essential for security purposes that key areas of building access be lit to a sufficient level to deter breaking and entering as well as vandalism. Also noted in the image is the location of 360 degree view security cameras, which are designated by red circles. These devices will help aid school staff and security monitor possible threats of intrusion while acting also as a deterrent to such acts.

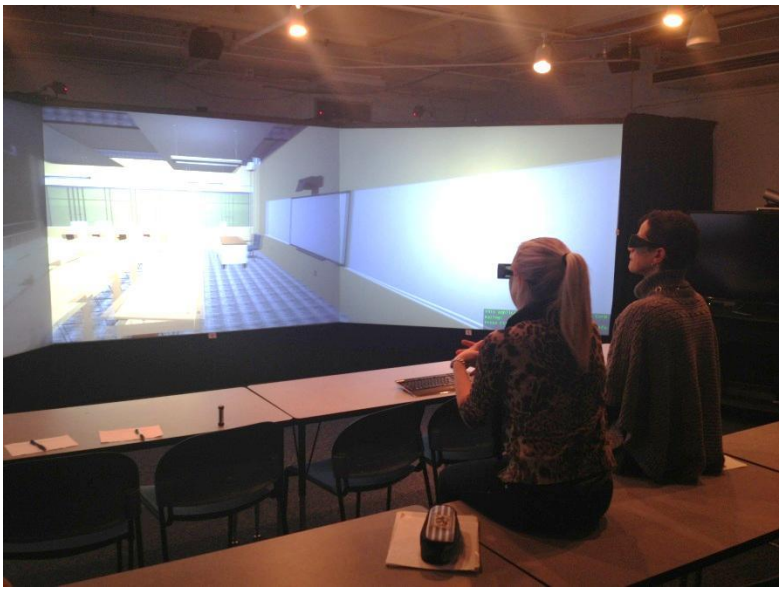


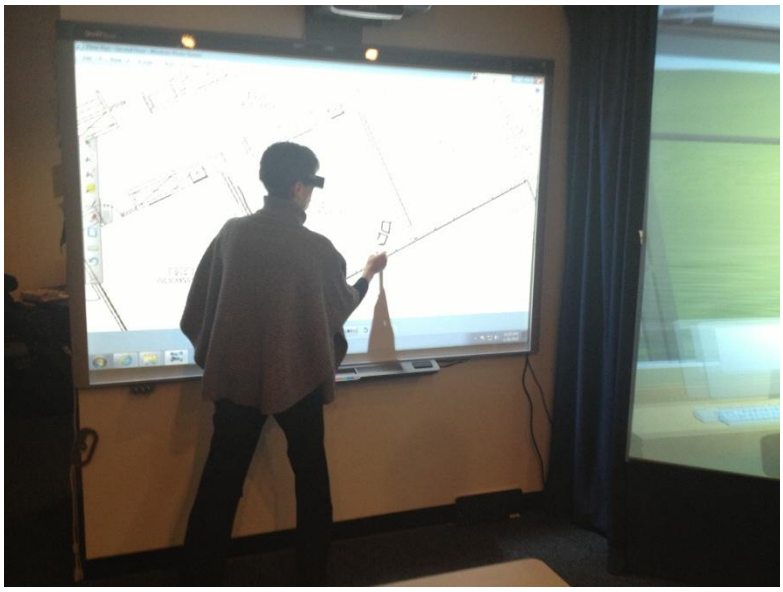


See Enlarged Drawing on I-8

Virtual Design Review

The following shows images of the model created using Unity 3D as well as additional photographs taken from the design review session.





Virtual Design Review – Meeting Minutes

The following sheet was used during our design review meeting meetings to track all of the feedback. The sheet for each meeting was saved in the common drive folder so that all team members could easily refer back to discussed topics. There were four main areas of focus that we wanted to get user feedback on while also allowing the experts to provide additional comments.

Virtual Design Review I MINUTES

Meeting Information

Date: January 18, 2013 Time: 11:00:00 AM Location: 3D Immersive Lab

Meeting Called By:	AEI Team 5	Attendees:	AEI Team 5
Type of Meeting:	Design Review		University Educational Department Head
Note Taker:	AEI Team 5		Sophomore Majoring in Early Education

Agenda Topics

- Classroom Design & Layout
- Security
- Other Building Areas
- Site

Feedback

Classroom Feedback

- The use of modular furniture on wheels
- Somehow providing room for children to sit on the floor
- Have the teachers desk angled for more room (Move floor boxes accordingly)
- Get rid of desktop computers or make them handicap computer desks
  - Possibly include only one or two
- Provide additional shelves for the locker casework (possibly a 2nd shelf to split up the locker)
- Extend whiteboard to wall so the wall space is not wasted
- Move clock above door
- Include additional casework at sink location

Security Feedback

- Frost glass next to door instead of clear glass
- Provide bulletproof and shatterproof glass on all of the first floor(definitely worth the money)
- Make sure that the Man trap is inviting
- Teachers need to be educated on all of the security for a better understanding of all systems
- Require parent/guardian ID Cards at the main entrance during school hours
- Provide a first alert badge that allows the teachers signal assistance

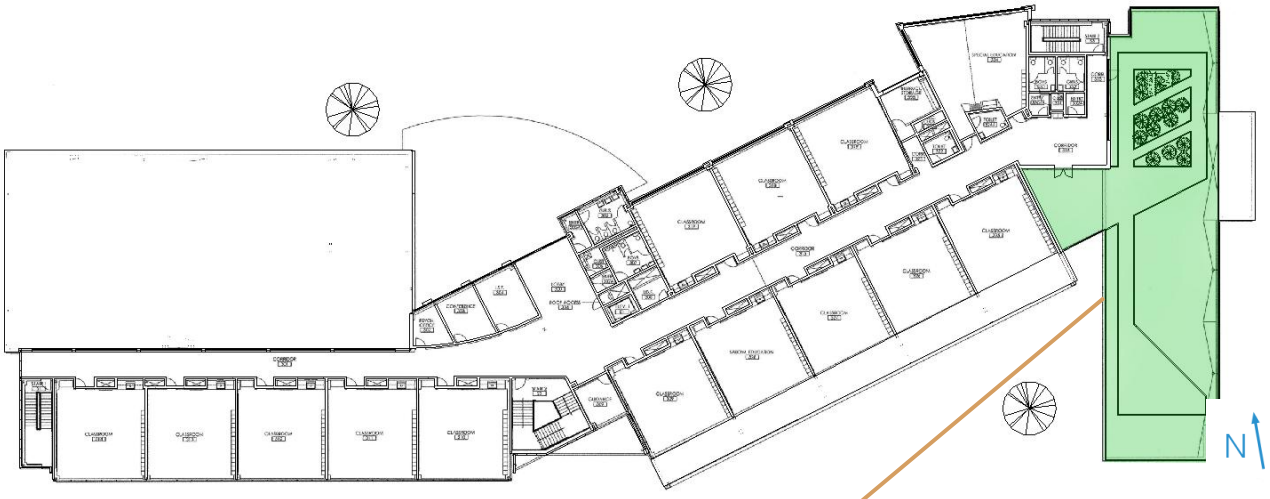
Other Building Areas Feedback

- A tiered sitting area on the green roof might be beneficial to the students
- Provide a 2nd Exit on green roof (check code if required)
- Include a higher parapet not a fence, students tend to climb fences
- Design a shade at the SE corner for possible outdoor classroom
- Some students require transgender/family bathrooms at pool

Site Feedback

- Do not provide an overpass for students to access the field across the street
- Storage shed will be needed with security cameras (cameras already included by Team 5)
- Fence the entire in with a see through, non-climable fence

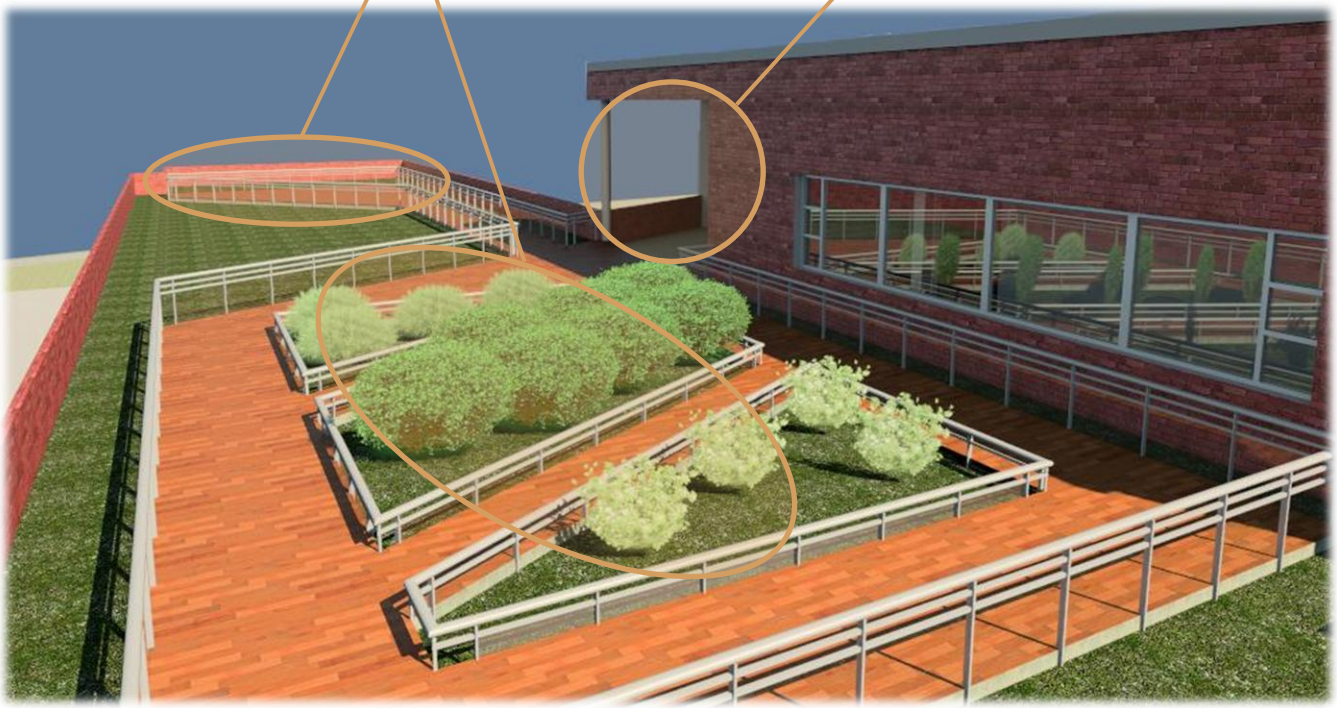
Green Roof



- Located Atop East Wing of 2nd Floor
- Total Area ~ 5,000 SF
- Total Walking Space ~ 2,200 SF

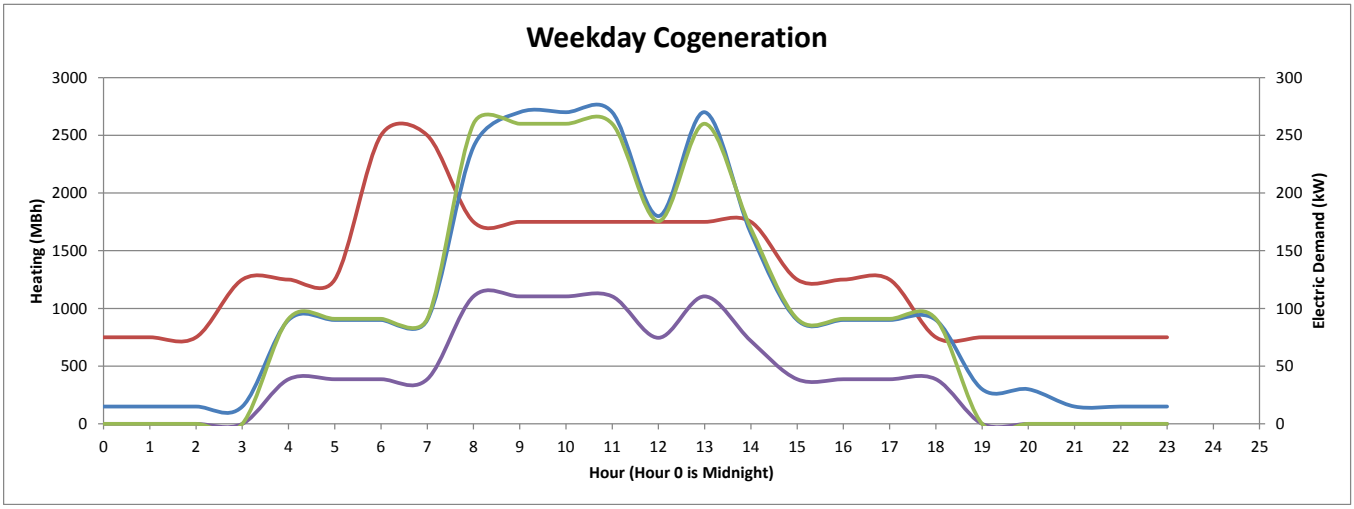
- One Part Classroom Garden
- One Part Outdoor Auditorium Space

- Access From Third Floor
- Not Available to the Public



Microturbine

The team chose a CHP system involving four (4) 65 kW on-site natural gas microturbines. The full system description can be found in the Mechanical Systems Submission. CHP system designs are naturally constrained by many multidisciplinary factors, and thus a fluid exchange of information regarding the CHP system was required to design it. The factors that constrained the system included:



RED = Thermal load
BLUE = Electric load
PURPLE = Collected exhaust heat
GREEN = Generated electricity

- Design heating electrical loads – The CHP capacity was selected to match thermal and electrical loads, but never to exceed them. The electrical and mechanical teams utilized an excel spreadsheet to estimate the building loads on typical days throughout the year, and integrated those loads to predict the overall annual energy use.

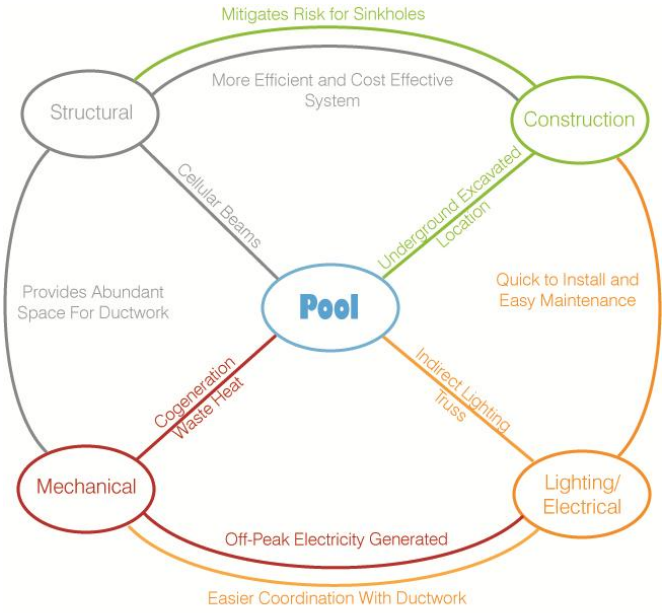
- The swimming pool – Inclusion of the swimming pool presented a significant year-round heating load. Exhaust heat from the CHP system could be used for this load, but the amount of heat required by the pool depended on its schedule of operation. Security concerns prevent the pool from being open to the public at all times, so the team

- Building codes and utility pricing – The CHP system required full information regarding local codes and utilities. The entire team was required to obtain and analyze this information.

Microturbine Cost (http://www.wbdg.org/resources/microturbines.php)		
300 kW		
Category	Avg. $/kW	Cost
Initial Cost	$900	$270,000
Heat Recovery	$213	$63,750
Total Equip. Cost		$333,750
Installation (% of others)	40%	$133,500
Microturbine Installed Cost		$467,250
Avoided Generator Cost		-$200,000
Energy Grant		-$250,000
Total Initial Cost		$17,250
Yearly Maintenance (kWh)	$0.0105	$10,500
*estimate 1,000,000 kWh/year		
Avoided Generator Cost ($/yr)		-$2,000
For 20 Year Life		$170,000
System Life Cycle Cost		$187,250
Yearly Energy Savings		$56,125
Payback Period (years)		3.34

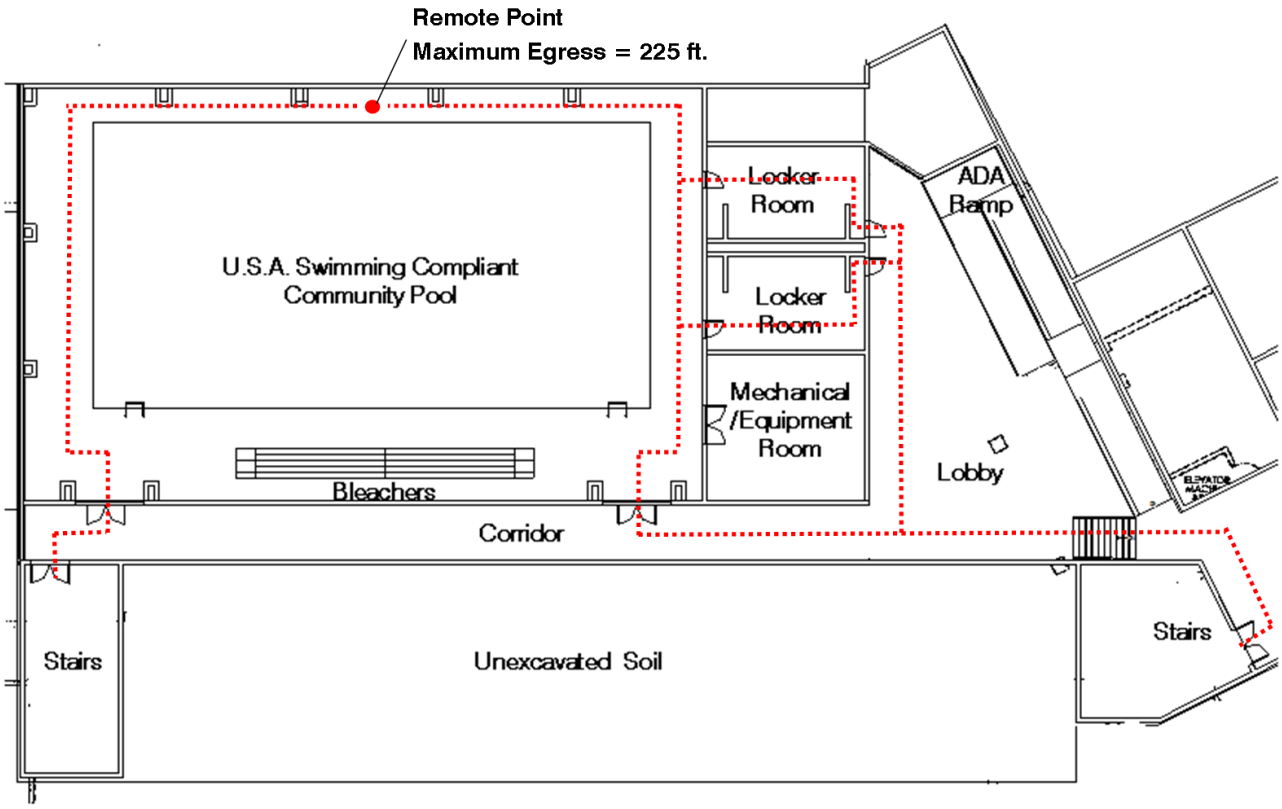
Pool

Pool Integration Diagram



The diagram to the left expresses how each discipline played a role in final pool design and selection of systems in this area.

Path of Egress

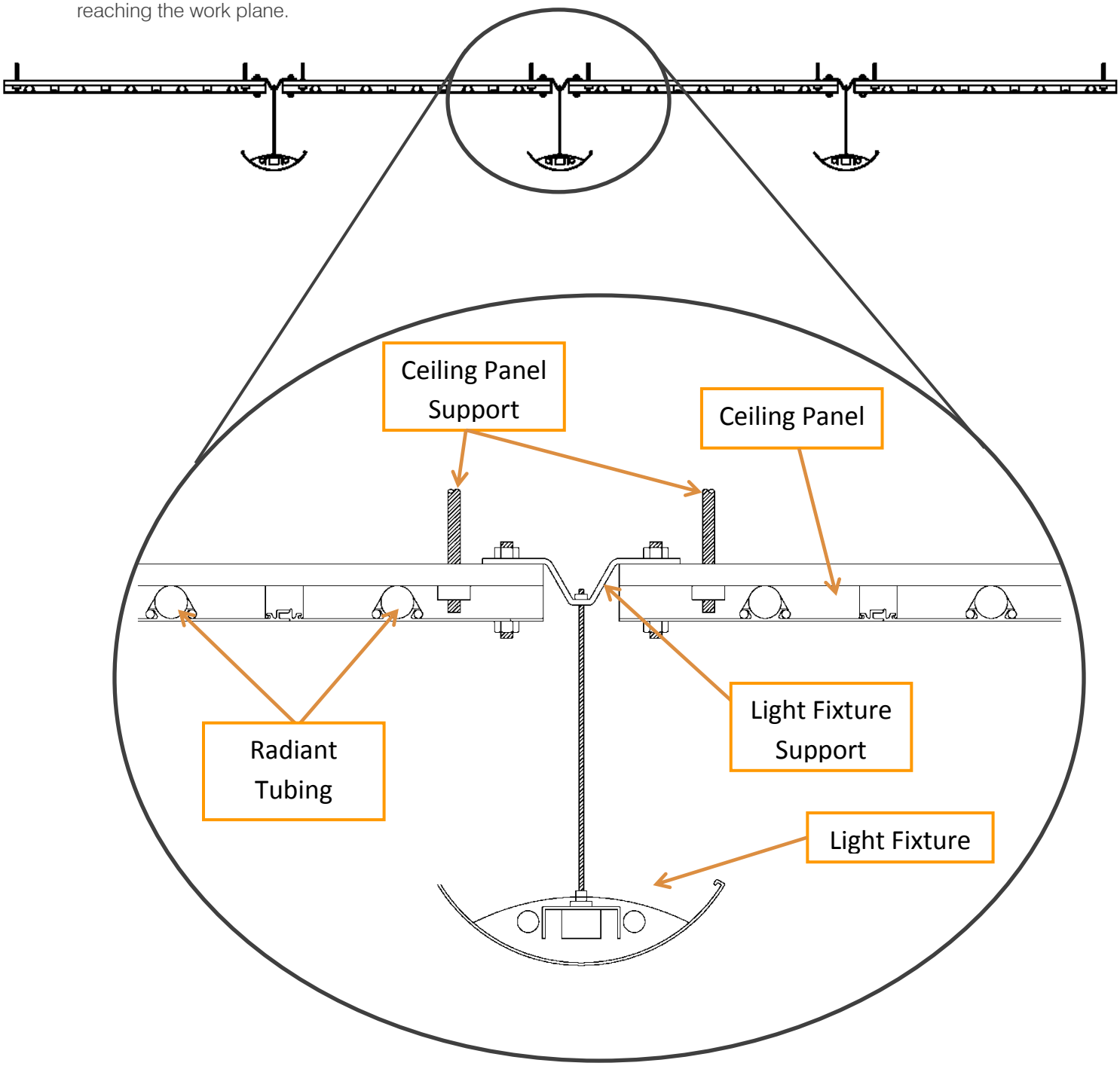


Pool Cost

Adding in Basement (RS Means 2013)				
Pool	**Unit**	**Quantity**	**Cost**	**Total**
Plumbing	SF	11500	$16	$184,000
Electrical	SF	11500	$20	$230,000
MEP Equipment	SF	11500	$0	$0
MEP Distribution	SF	11500	$17	$195,500
TOTAL				**$609,500**
Difference to Design	**Unit**	**Quantity**	**Cost**	**Total**
piles	Cluster	5	$12,775	$63,875
Pile caps	EA	5	$830	$4,150
Grade Beam	LF	0	$105	$0
Excavation	SF	13000	$17	$221,000
Shoring	LF	220	$1,304	$286,902
Foundation Wall	LF	470	$460	$216,200
Beam-Steel	SF	11608	$10	$116,080
Column-Steel	VLF	580	$120	$69,600
1ST Floor Construction(adjusted)	SF	11608	$15	$174,120
Windows	SF	-1350	$26	-$34,965
Stairs	EA	1	$20,000	$20,000
Stair & Ramp	EA	1	$12,500	$12,500
TOTAL				**$1,149,462**
Pool Requirements	**Unit**	**Quantity**	**Cost**	**Total**
Beam-Steel	SF	11608	$10	$116,080
Roof Construction	SF	11608	$15	$174,120
Windows	SF	270	$26	$6,993
Interior Walls-block	SF	3200	$15	$48,000
Interior Wall-stud	SF	2400	$6	$14,400
Floor coverage	SF	11200	$11	$123,200
Ceiling-drywall	SF	5000	$5	$22,500
Ceiling-acoustical	SF	6200	$5	$32,860
Door Interior	EA	7	$1,000	$7,000
toilet partitions	EA	5	$800	$4,000
entrance screen	EA	2	$340	$680
urinal screen	EA	2	$365	$730
Shower Partitions	EA	6	$1,150	$6,900
Lockers	EA	70	$125	$8,750
Accessories	Per Toilet	6	$500	$3,000
casework	Project	1	$10,000	$10,000
Bleachers	EA	1	$15,000	$15,000
Excavation	SF	13000	$1	$13,000
TOTAL				**$607,213**
Total Cost				$2,366,175
Cost/SF				$204

Ceiling Panel Detail

The detail show below gives a view of how radiant ceiling panels are integrated with the chosen lighting fixtures. Having the ceiling panels painted white, allows for higher reflectivity thus maximizing the distribution of diffuse light reaching the work plane.



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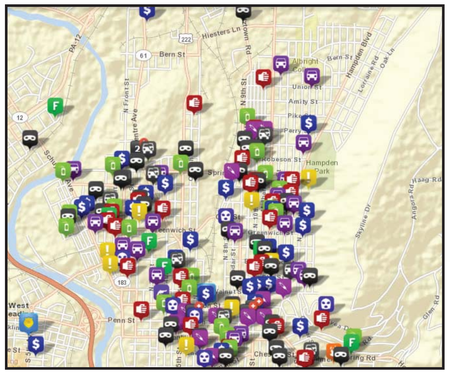
ELEMENTARY SCHOOL SITE:

Site selection and site planning were major areas of integration for our team. The site was selected to maximize safety, which is an issue at Reading public schools, and also takes advantage of nearby facilities such as Albright College and other Reading elementary schools. The construction site was planned to allow continuous operation of the existing elementary school on the site.

Reading Elementary School Site - Intersection of 13th Street and Union Street

N

Crime Investigation Results



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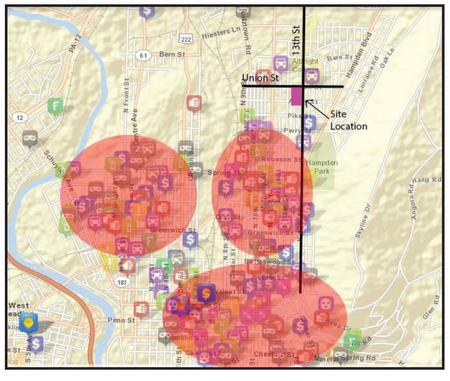
Highlighted Areas of High-Density Crime



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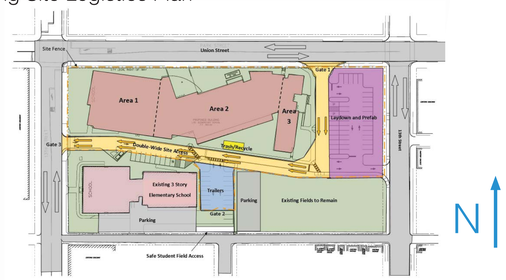
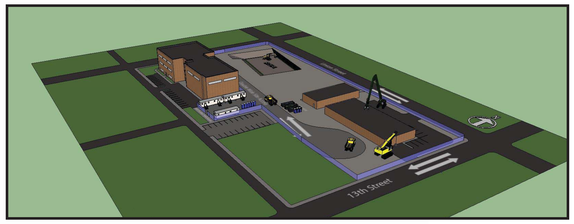
SITE SELECTION:

The Reading community along 13th street was analyzed from a crime perspective using crimemapping.com. The team chose the site location to avoid the high density areas of crime.

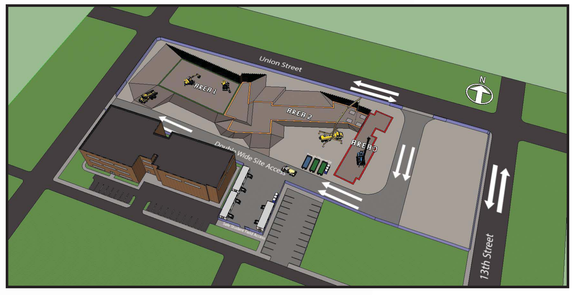
Building Site Logistics Plan



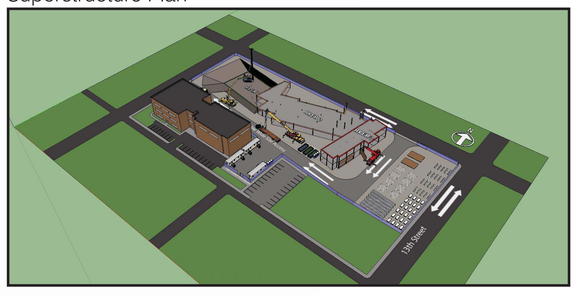
Demolition Logistics Plan



Excavation and Foundations Plan



Superstructure Plan



INTEGRATION-1

Team Registration Number 05-2013

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SITE PLAN

COMMUNITY GARDEN:
The community garden was modeled and analyzed for security and accessibility. Throughout the design of the garden, changes were made to accomodate ADA compliance and make the area feel safe through the use of outdoor lighting.

FACADE MODELING:
The prefabricated facade panels were modeled in REVIT to verify sizing and quantity of panels. Each of the facade panels is an individual component.

GREEN ROOF:
The green roof was modeled as part of an expert design review session as described in the Integration Narrative. The education reviewers helped the team design an outdoor learning experience that is both functional and memorable.

3D VIEWS

INTEGRATION-2

Team Registration Number 05-2013
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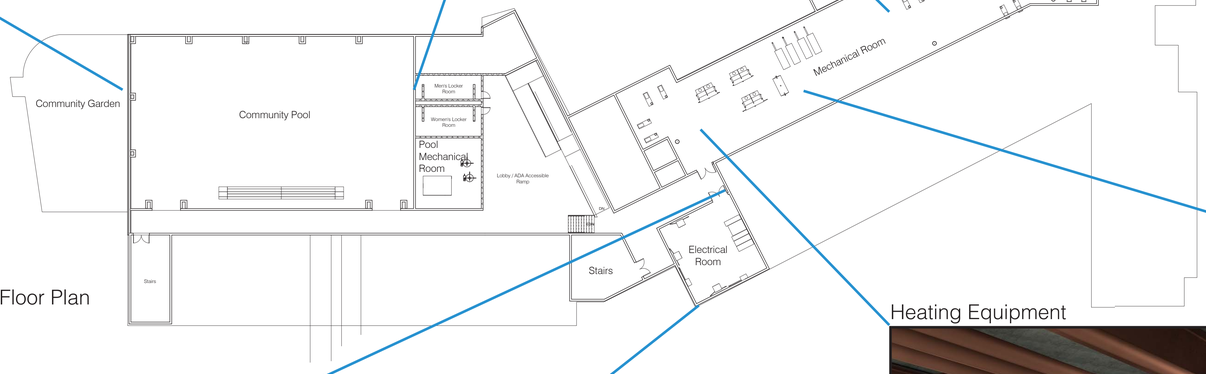
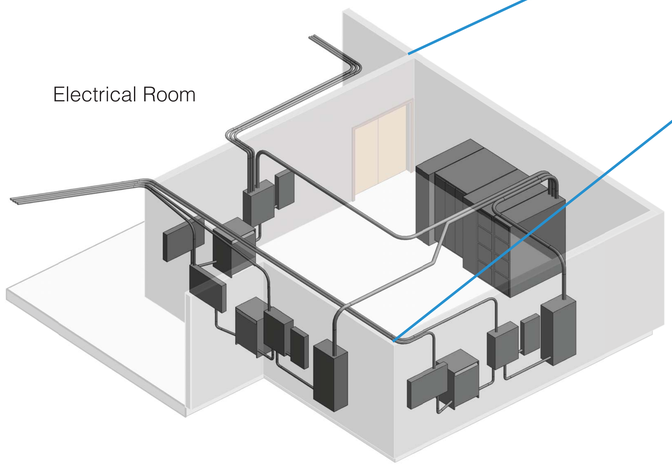
CELLULAR BEAMS:
Long span cellular beams were used in the pool area to help meet pool room height guidelines set by USA Swimming. Mechanical ducts could easily be run through the large circular holes in the beam webs.

Pool and Cellular Beams



Basement Floor Plan



Electrical Room

MECHANICAL & ELECTRICAL ROOMS:
The mechanical and electrical rooms were deemed to be “critical” spaces for engineering disciplines in terms of clash detection and organization. Thus, the mechanical and electrical rooms were fully modeled in revit down to piping. Valves and other pipe accessories were not modeled.

Chilling Equipment

Heating Equipment

INTEGRATION-3

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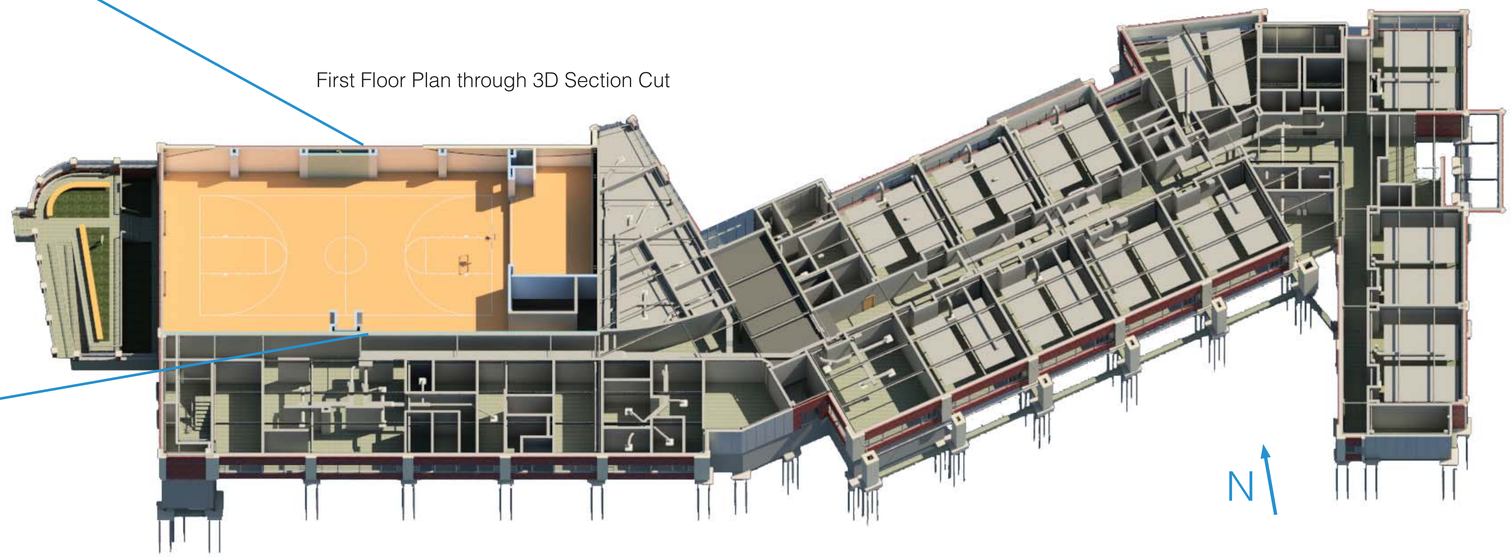
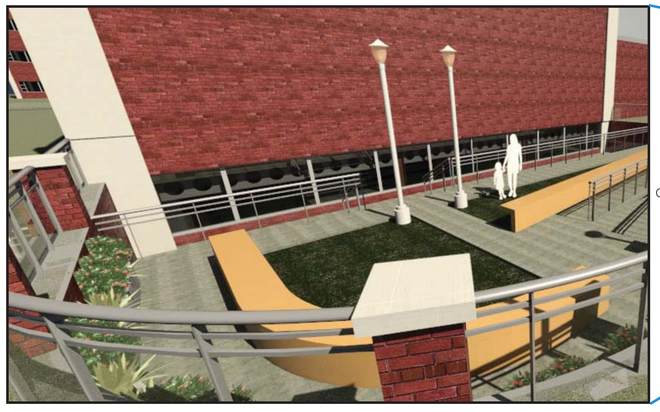
BASEMENT

MULTIPURPOSE GYMNASIUM:

- Acts as a gym, cafeteria, and assembly space during school hours
- Open for community use during non-school hours
- Natural disaster shelter - combined heat and power system provides electric power and heat in the case of a downed electric grid

First Floor Plan through 3D Section Cut

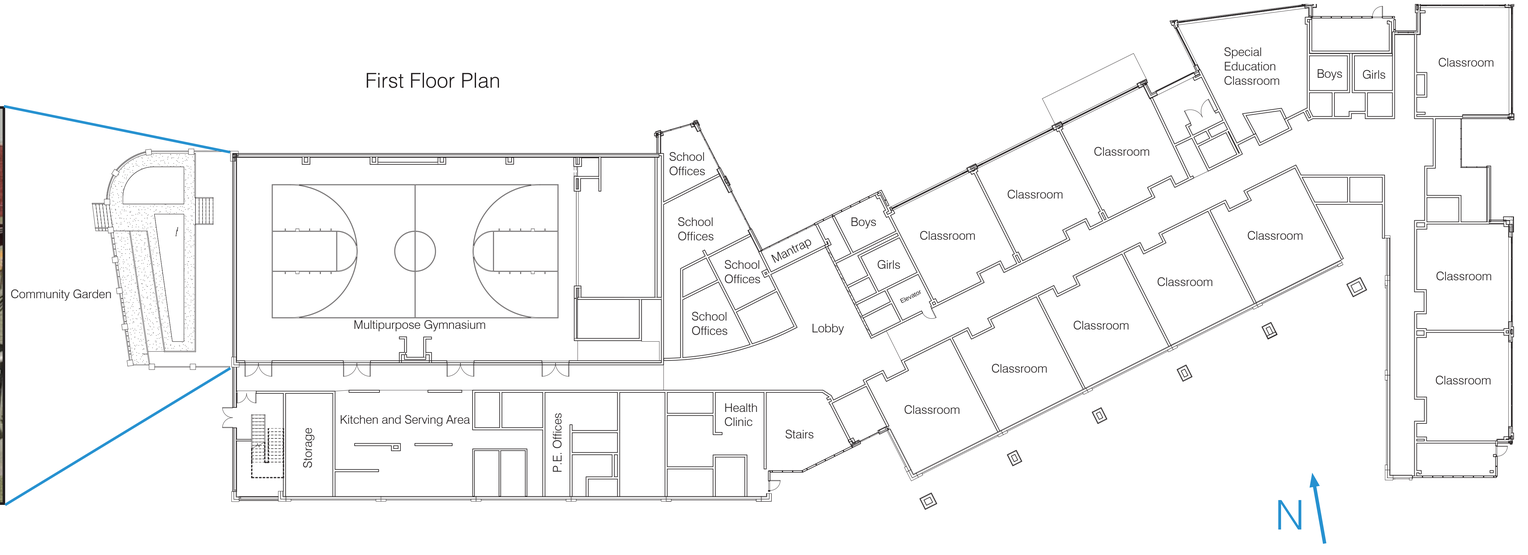




COMMUNITY GARDEN:

- Unique way to bring daylight into pool area below
- Students and community members may both participate in gardening

First Floor Plan



INTEGRATION-4

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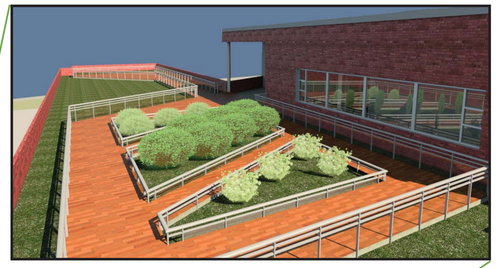
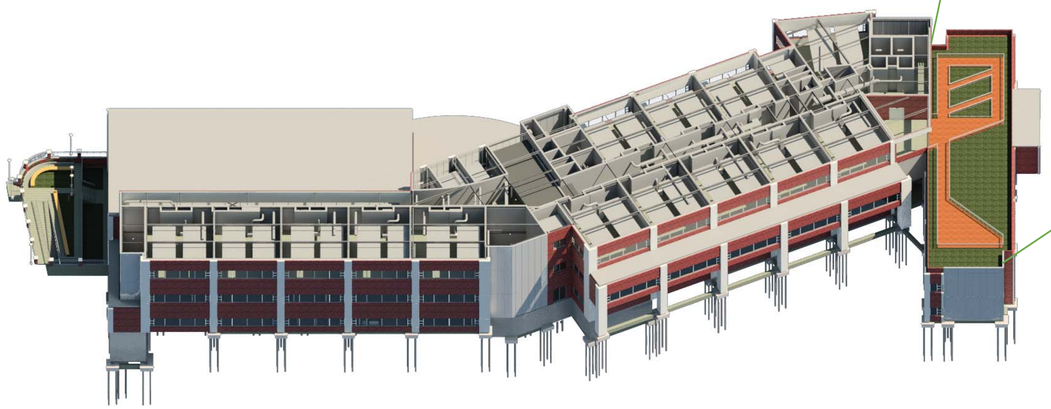
FIRST FLOOR

SECOND AND THIRD FLOORS

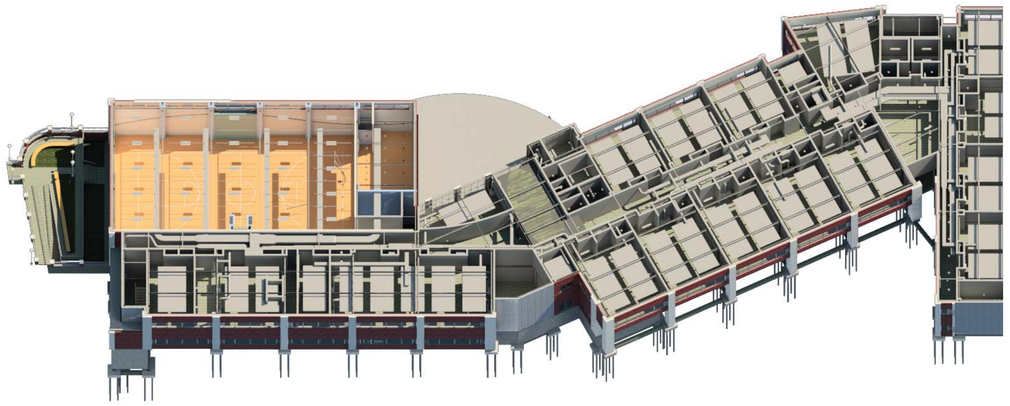


GREEN ROOF & OUTDOOR LEARNING SPACES:
Classes can be held outdoors in the versatile green roof space. Normal classes may occur outdoors in the partially covered learning area, or students may learn about plants and gardening in the outdoor garden space.



Third Floor Plan through 3D Section Cut

Third Floor Plan



Second Floor Plan through 3D Section Cut

Second Floor Plan

INTEGRATION-5

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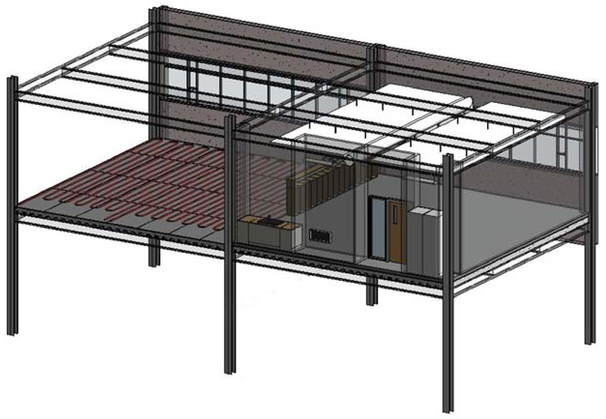
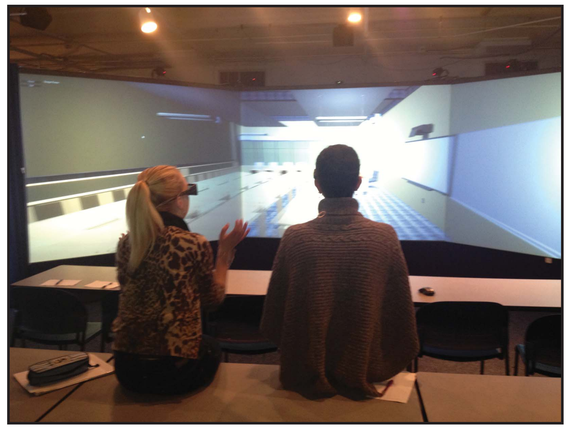
CLASSROOM DESIGN PROCESS:

The following iterative process was used to design an enhanced learning space.

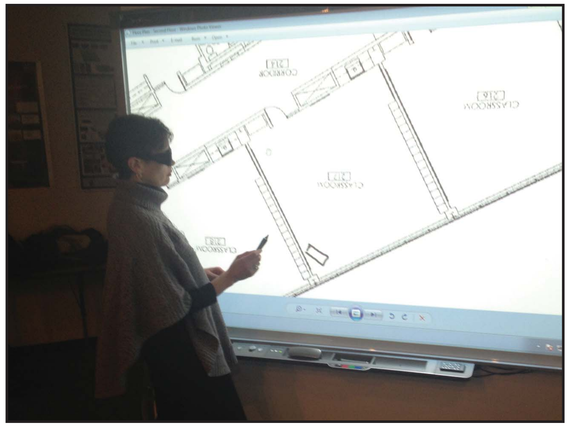
Step 1:
Model classroom mockups in REVIT



Step 2:
Transfer to REVIT mockup model to UNITY 3D - the result is an interactive model that reviewers can “walk through”



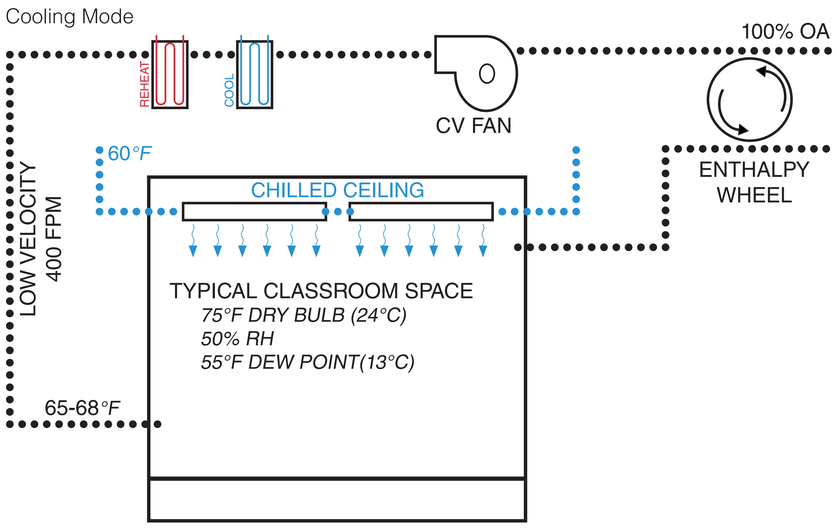
Step 3:
Present design to expert reviewers and receive feedback of the design

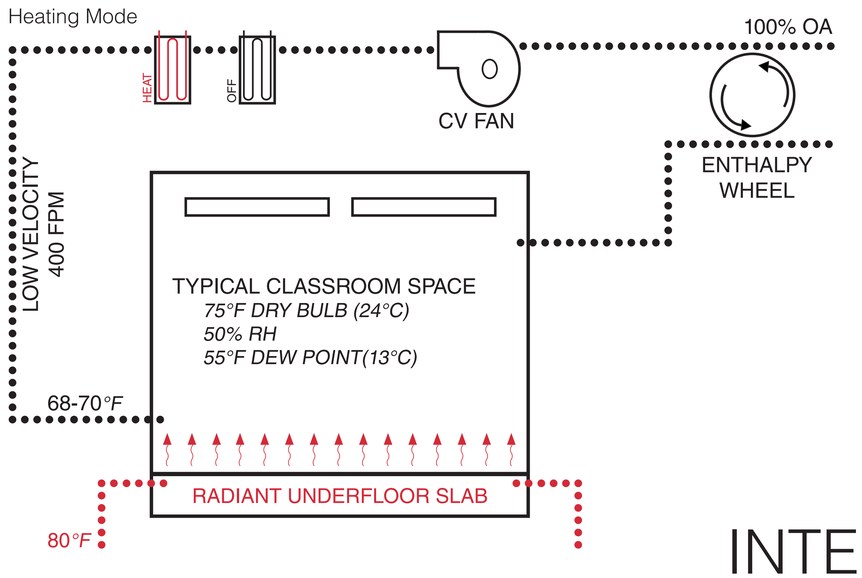


Note changes from design review - fix changes in mockup and repeat entire design review process

CLASSROOM ENVIRONMENTAL QUALITY:

The classroom heating, cooling, and ventilation strategies were a major team decision. In addition to creating a comfortable and energy-efficient classroom environment, indirect lighting and fire protection is hung from the chilled ceiling panel structure.





CLASSROOM SYSTEMS

INTEGRATION-6

Team Registration Number 05-2013

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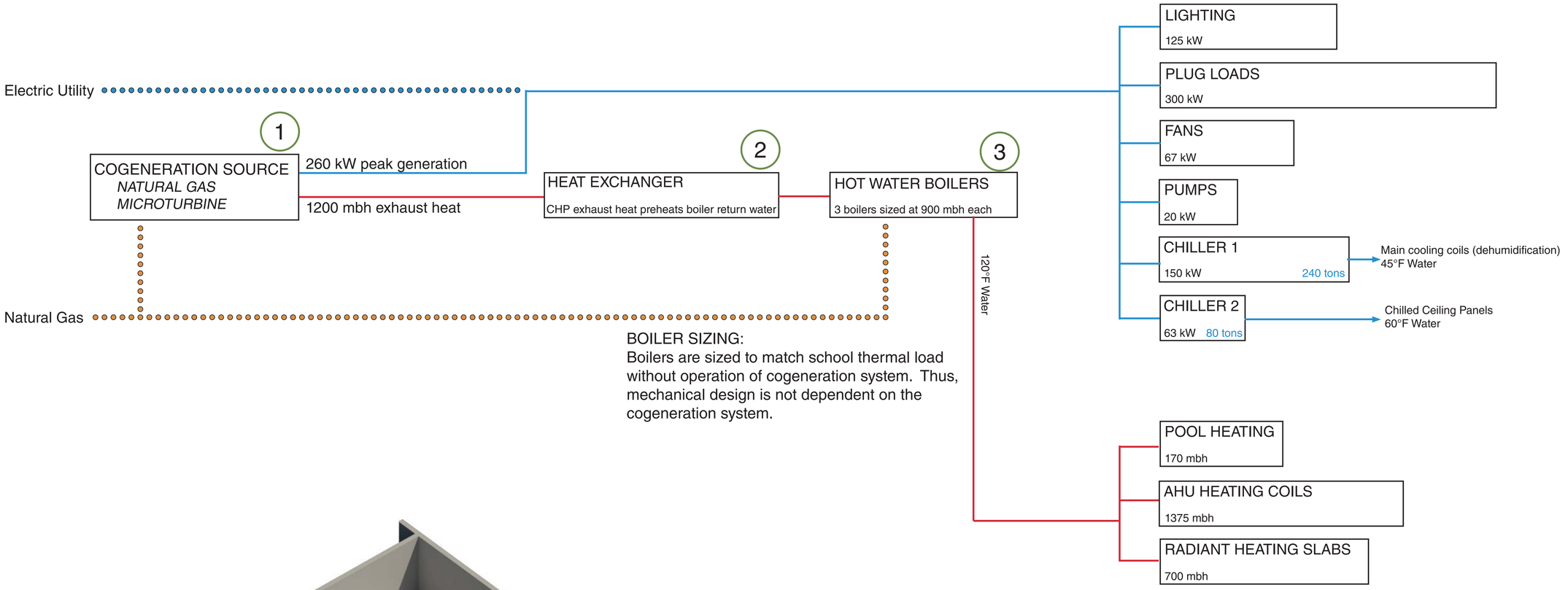
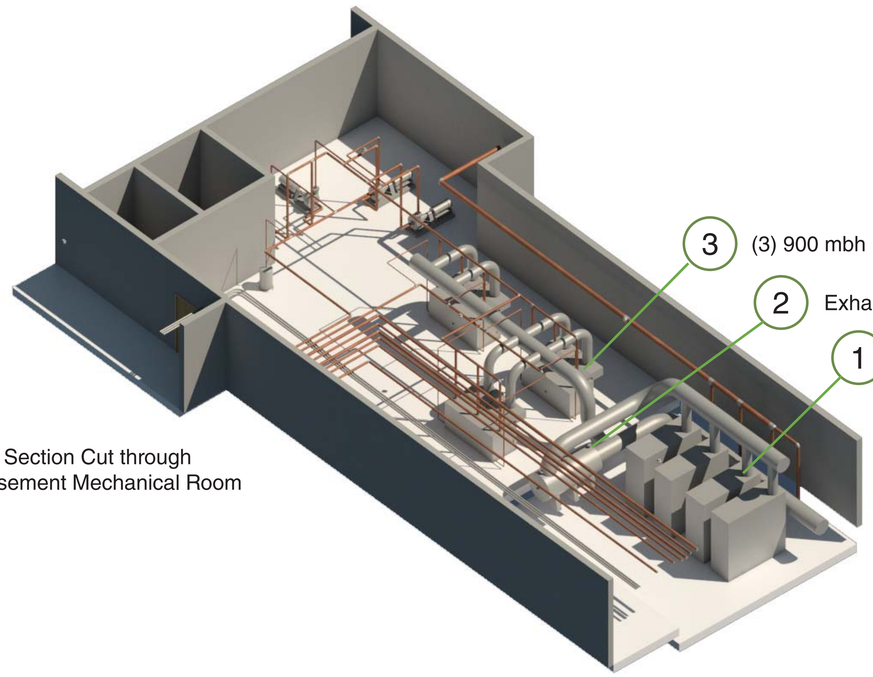
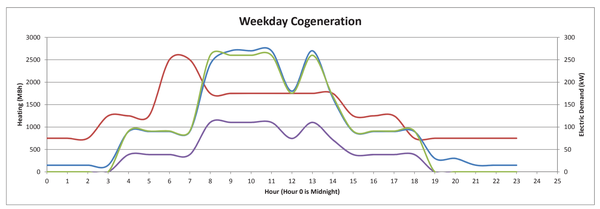
COMBINED HEAT AND POWER



BOILER SIZING:
Boilers are sized to match school thermal load without operation of cogeneration system. Thus, mechanical design is not dependent on the cogeneration system.



3D Section Cut through
Basement Mechanical Room



CHP LIFECYCLE COST:
Electric and Mechanical disciplines worked together to make buiding load profiles for typical weekdays and weekends for every month of the year. These profiles were important in guaging how much the CHP system could be run, thus being able to calculate the energy savings from the system. The created profiles were used in all energy modeling calculations throughout all disciplines of the project.

INTEGRATION-7

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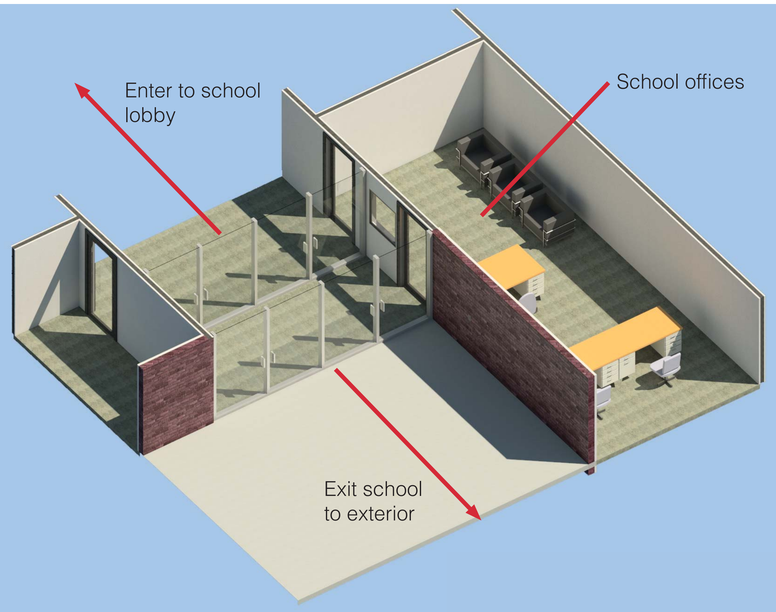

Man Trap

Operator has ability to lock vestibule doors and “trap” threat until police arrive.

Classroom Locks

All classroom spaces are lockable from inside. Should threat trespass to classroom wing, silent alarm will alert school administration to lock classrooms, turn off classroom lights, and collect students to interior wall.

Stairwell Locks

During community hours, stairwells within community space (marked in red are locked to prevent access to floors not part of community agenda.

Mantrap Sequence of Operation

1. Any visitor who wishes to enter school rings doorbell.

2. Surveillance camera will be used by school office staff to do a quick visual inspection of the person.

3. School office staff can unlock front door, inner vestibule door remains locked.

4. School office staff may talk to visitor and verify their intentions to enter school.

IF THREAT IS RECOGNIZED:
- School office staff may re-lock front door from automatic switch, “trapping” threat in the vestibule. All vestibule glass is impact resistant.

IF VISITOR IS DEEMED SAFE:
- School office staff may unlock second vestibule doors or door into school office via automatic switch.

Card Reader Access

All secondary entrances (marked in green) require card reader access to supervise and regulate visitor acess.

Automatic Locks

Should threat progress past man trap, panic button located in the administrative area may be pressed to automatically lock doors to classroom wings, confining threat to atrium space.

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INTEGRATION-8

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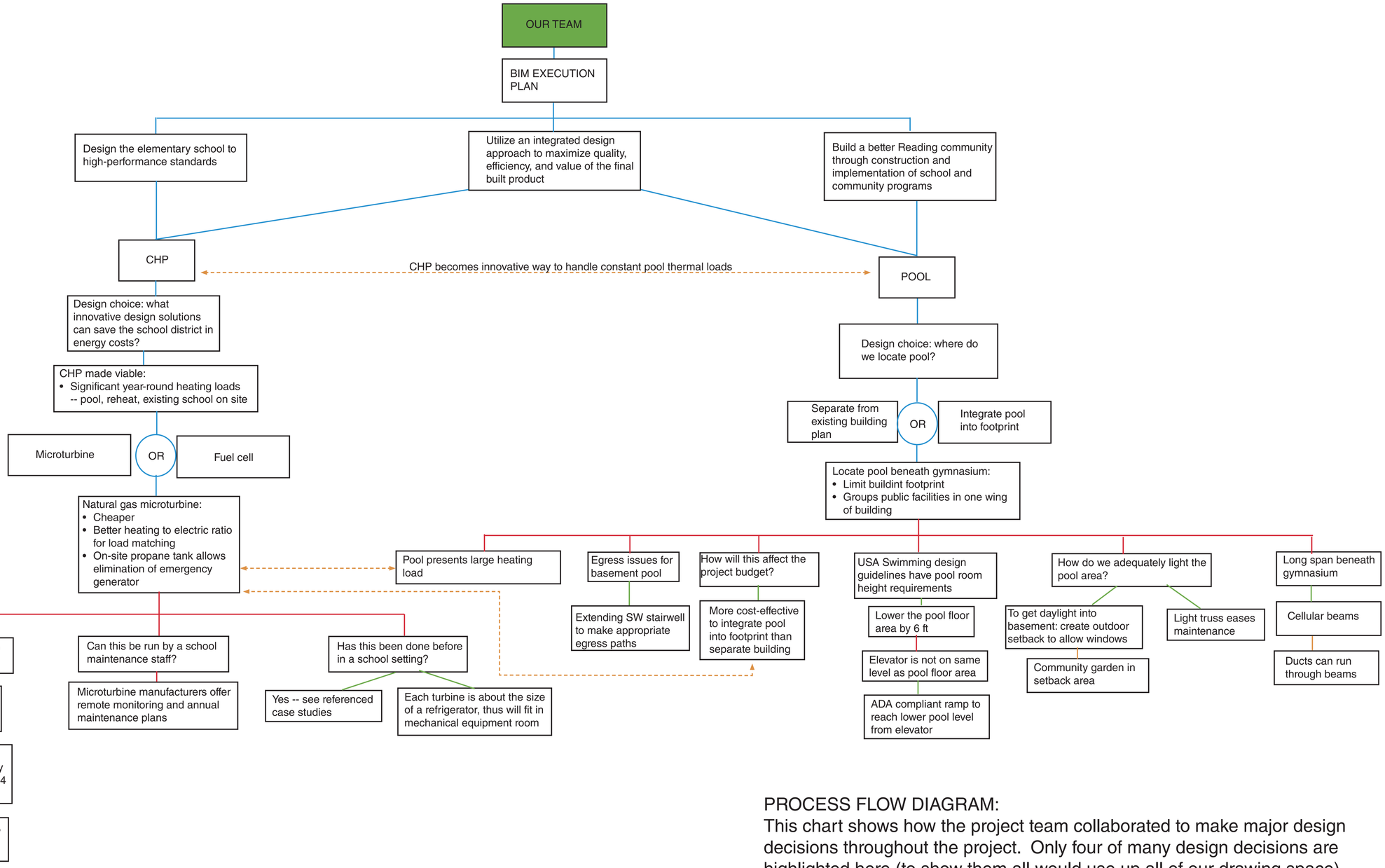
SECURITY

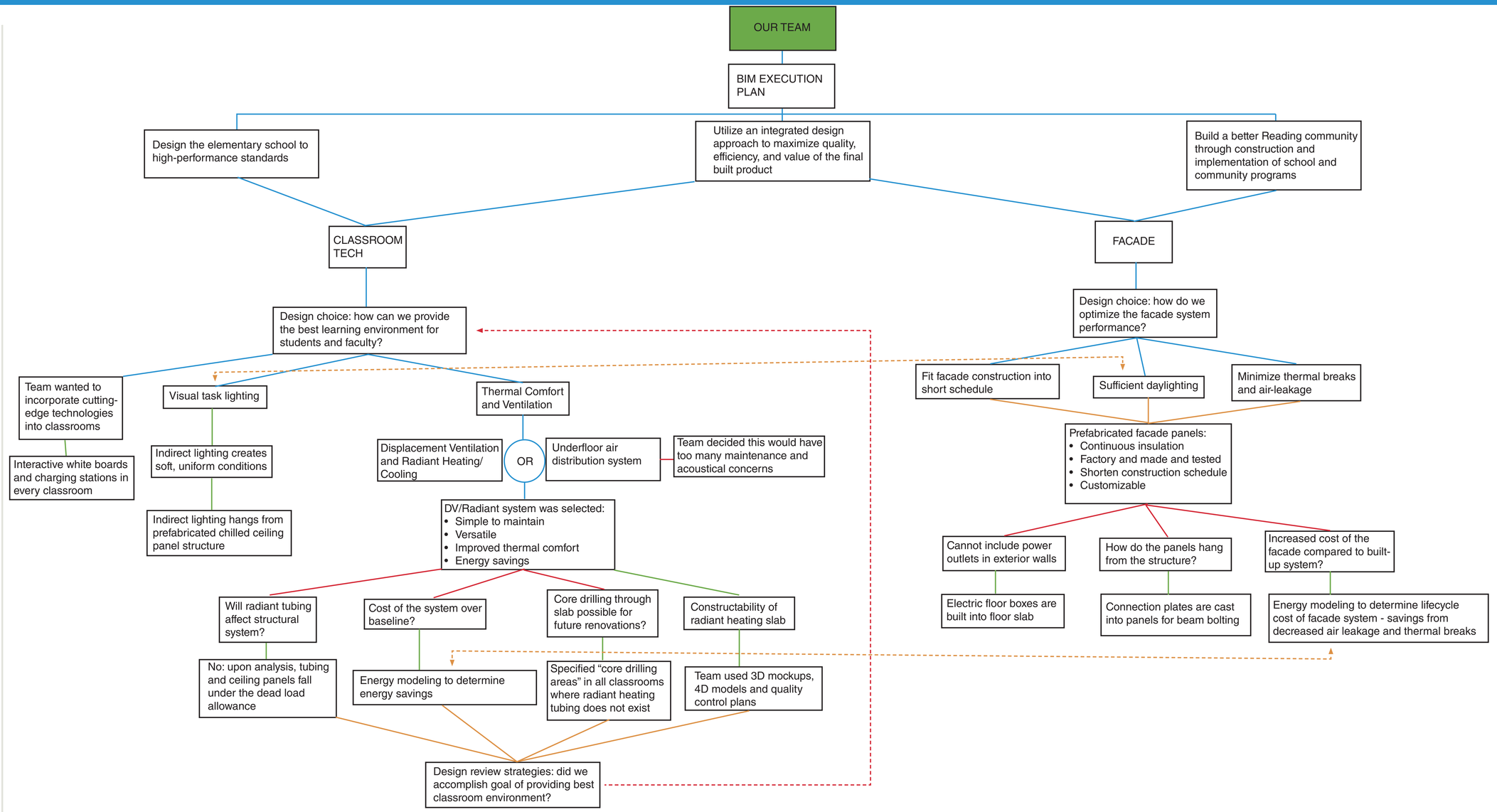


PROCESS FLOW DIAGRAM

PROCESS FLOW DIAGRAM:
This chart shows how the project team collaborated to make major design decisions throughout the project. Only four of many design decisions are highlighted here (to show them all would use up all of our drawing space). By making these decisions, we were successful in acheiving our project goals.

KEY:
Blue - General thought process
Red - Concern
Green - Solution
Orange - Integration

INTEGRATION-9
Team Registration Number 05-2013
ASCE Charles Pankow Foundation Student Competition



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KEY:
Blue - General thought process
Red - Concern
Green - Solution
Orange - Integration

INTEGRATON-10
Team Registration Number 05-2013
ASCE Charles Pankow Foundation Student Competition