nexus

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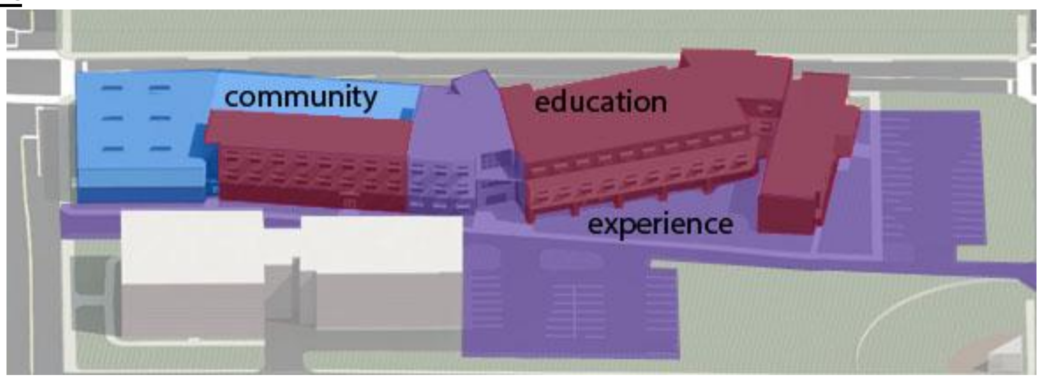
Content



The requirements of a typical elementary school, in conjunction with the socioeconomic conditions of the Reading school district necessitated unique design decisions and innovative solution. To achieve this, a set of categories was created to define the purpose of each space in the school. It was determined that the three major functions of the building included **Experience**, **Community**, & **Education** spaces. The function of these three unique aspects dictated the integrated design of the various building systems. This too, became a manner of dividing the building in terms of system types and discipline coordination. As such, these will be the key aspects of discussion and integration in the following content.

Executive Summary **2**
- Introduction
- System Summary
- Mechanical Design Goals 3

Passive Mechanical Solutions **4**
- Building Envelope 4

Mechanical System Solutions
- Heat Recovery 4
- Dehumidification/Humidification 6
- Heating, Ventilation, Air Conditioning 6

Coordination & Integration

Conclusion

Supporting Documentation / Appendix **16**

1. Executive Summary:

1.1 Introduction

In designing a mechanical system for the Reading Elementary School many socioeconomic, constructability, and sustainability factors were taken into consideration. The preliminary/baseline calculations presented us with a 70,000 cfm and 190 ton load requirement for the building. The mechanical design criteria to **reduce, recover,** and **reuse**, in conjunction with the objectives of the other design disciplines, were met through the implementation of an integrated façade, a unique lateral duct configuration, in addition to an innovative Ethylene Glycol run-around system. The integrated façade will maximize interior daylighting while minimizing infiltration and solar heat gain by ____%. The unique lateral ducting configuration will allow for a 30% increase in outdoor air ventilation to be introduced to the classrooms while minimizing initial installation costs and eliminating conflicts with the other design disciplines. Finally, the implementation of the Ethylene Glycol recovery system will reduce the total building load by 50% through a maximum heat recovery rate of 65%. These savings will allow for a cost effective building in both upfront and lifecycle costs; both of which are of the utmost importance to the owner and Team Nexus. This design and integration of the mechanical system with the other disciplines will ultimately enhance the overall building **experience** to provide a top-of-the-line facility for **education** and the **community**.

1.2 System Summary

The recovery system manufactured by Konvekta was used in the determining the efficiency and cost analysis of this system as it was found to be the most efficient form of recovery at 65% recovery with the addition of the pool and 60% without the pool. This allows for drastic energy savings in short and long run cost analysis. Although there will be an increase in mechanical upfront cost of about 20-30%, this increase will be offset by a 3-5 year payback period due to the system efficiency. Additionally it is a packaged system that does not impact construction schedule and allows for a flexible layout. The system too, will be a 100% outdoor air system to allow for maximized ventilation rates and an overall improved internal environment. This will earn the LEED Credit for 30% increase in the ASHRAE baseline ventilation requirements.

The largest design challenge is undoubtedly the pool as it is specified as an alternate phase to the owner. This requires an HVAC system with the capacity and flexibility the allow the addition the pool at a later date while still maintaining a maximized rate of recovery and efficiency. The system also incorporates a dehumidification loop to recover latent heat to be reintroduced or removed during the preconditioning of the outdoor air. The product has a guaranteed success rate of implementation by Konvekta as well; which proves to the owner that the investment in this technology will be beneficial over the building's lifecycle.

1.3 Mechanical Design Goals

The biggest challenge for selecting and designing a mechanical system became finding a balance between initial cost and lifecycle return. As a team, Nexus developed three main goals to use in achieving these design criteria; all three of which are visible the design decisions of the other disciplines and ultimate comprise one of the overall Team Nexus design goals. :

reduce, recover, reuse

Reduce: _Loads-_ To reduce up front and lifecycle cost the building need first require less energy to be conditioned appropriatly. The implmenetation of these systems reduces annual building load by about 50%; thus not only decreasing annual energy use but also allowing savings in a 50% reduction of boiler size.

Construction Schedule- This system will not impede construction sequencing as the 18 weeks required for manufacturing will allow the units to be ready prior to their scheduled date; additionally allowing time for delays and mishaps.

Maintenance/ Lifecycle Costs- After the intial payback period of 4.3 years for the implmentation of the HVAC system alone. The Konvekta system specified will only undergo a ruitine coil maintence bi-annually. This maintenance cost will be minimal in comparison to the savings due to the high system efficiency.

Recover: _Energy_- To further reduce the cost associated with energy waste, the Ethylene Glycol system will recover the thermal energy being exhausted by the HVAC system during both the heating and cooling seasons. This is done to retain a percentage of the energy spent conditioning the air for the respective building loads.

Reuse: _Energy_- This obviously plays directly into the aforementioned goal of recovery. By recovering the thermal energy being lost through the exhaust system and reimplementing it as preconditioning for the incoming outdoor air, will greatly impact the building’s lifecycle cost. This will be done at an efficiency between 40 and 65%; the latter ocurring during the heating season when the school is mostly in operation.

2. Passive Mechanical Solutions

2.1.1 Building Envelope

The first step in the mechanical design process was to create a mass model and analyze the site conditions to generate a basic energy model (as shown in Figure 1). This was done using Project Vasari, and allowed us to develop static mechanical designs to optimize the envelope of our building with considerations to specific to our site layout.

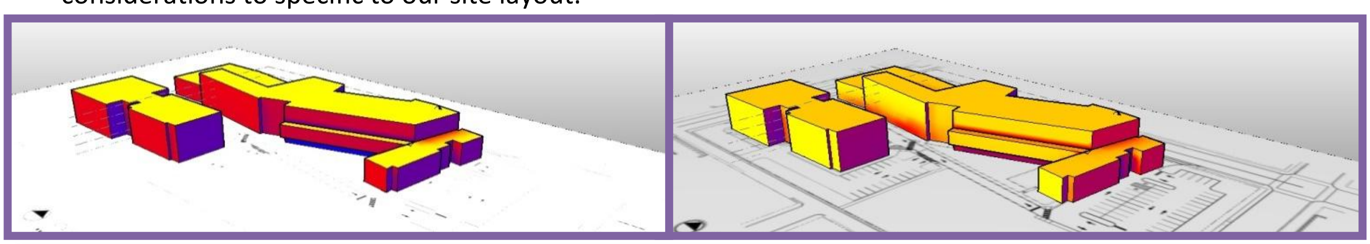
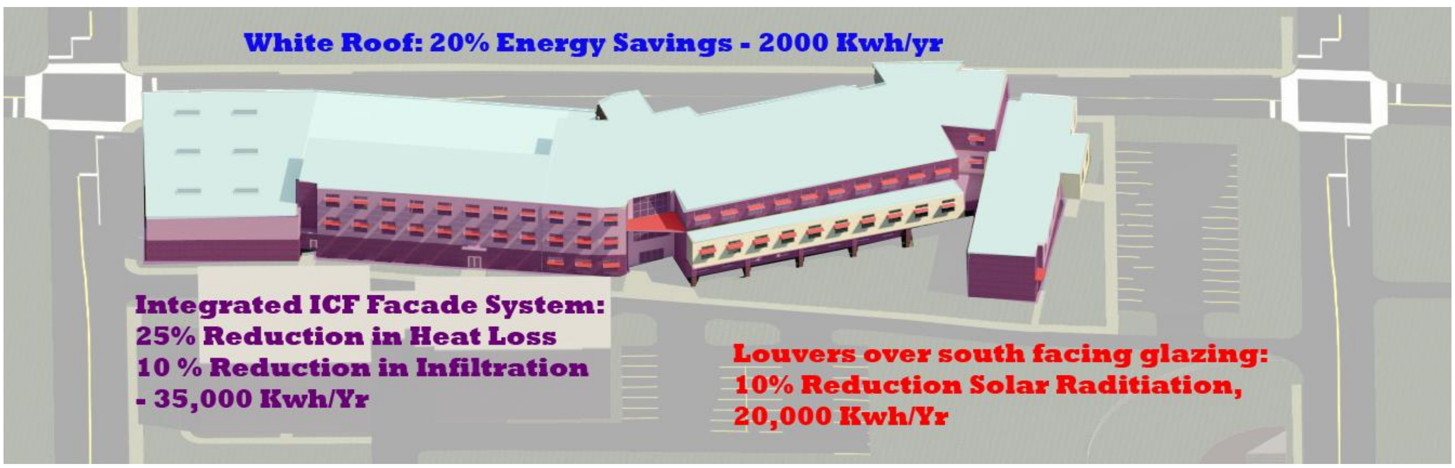


Figure 1: Vasari Model showing solar radiation on building envelope in summer (left) & Winter (right)

Using these modeling outputs in cohesion with the ASHRAE 2010 design criteria, it was determined that an ICF (Insulated Concrete Form) exterior wall construction be implemented. This system provides an R value of 24 and greatly decreases the rate of infiltration of thermal conditioning to the environment as this façade system provides a tighter seal than most. The ICF system too, greatly surpasses the ASHRAE minimum R-Value for Climate zone 5 by almost 20%. Special considerations were also taken into the glazing design for the building. The design goals of the Lighting/Electrical engineer required that the building utilize as much natural daylighting as possible. In working with the lighting designer a standardized window system was developed with a U-value of 0.28. It too should be noted that this glazing configuration comprises less than 30% of the entire exterior surface area which is well under the ASHRAE 2010 maximum design criteria of 40%. Additionally, the south facing glazing will utilize a 2ft louver that will shield the rooms from direct glare but also excessive solar heat gain during the cooling season. The iteration to the original roofing design was the replacement of the standard black roofing material with white roof on insulated decking. This will prevent the "heat-island-effect" which will allow for additional energy savings especially during the cooling season.

2.1.2 Rationale



In comparing the initial baseline energy model (which calculated building loads and energy requirements utilizing all minimum envelope requirements as per ASHRAE 2010) to the current model; taking into account only the change in the envelope design, the proposed building uses __% less energy. The baseline model graphic shown in Figure 2 shows the breakdown of these savings by Façade, Glazing, and Roofing materials .

The white roof will be constructed using an insulated acoustic metal decking as it's main source of support. This decking includes an additional layer of insulation to ensure that there an R-Value of __ is met as per the ASHRAE 2010 minimum design standard. The overall design of the envelope also allows for a change in the required airflows needed to condition the building. The baseline model provided a __________ cfm building with a ______ Load. With the implementation of the new envelope system the building loads have decreased to about ___.

2.1.3 Acoustics?

2.1.4 Acoustic Rationale?

3. Mechanical System Considerations

3.1 Heat Recovery

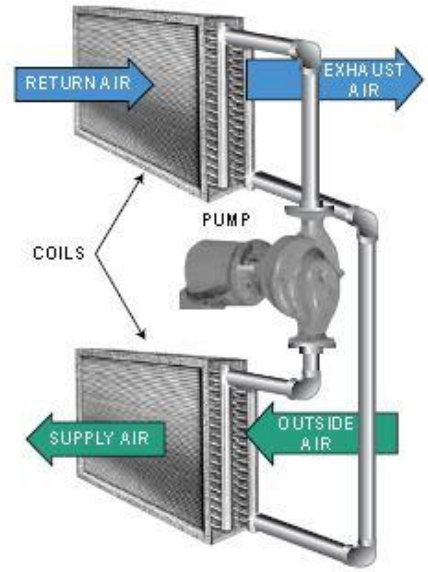


Figure 3: Traditional Runaround System
http://www.dac-hvac.com/blog/page/3/

As stated in the aforementioned mechanical goals, recovering lost energy is considered one of the most important design criteria. Therefore and Ethylene Glycol runaround system was selected to be the best system to handle our building needs. The system specified by our design is one made by Konvekta and started being used in applications in the United States for the past 5 years. It works in the manner of a traditional runaround system by capturing thermal energy from the exhaust air and reintroducing it to precondition incoming outdoor air (Figure 3). There are three components of the Konvekta run-around system that make it more 20-30 % more efficient than a typical run-around recovery system. This allows Konvekta's system to recover 60 – 90% of energy that escapes the building in exhaust. This differs greatly from the 40-60% of energy recovered via a traditional runaround system. These three differentiating components are as follows:

Figure 4: Konvekta Counter flow Coil
www.dac-hvac.com/blog/

1) **Coil Array:**
   - Traditional systems use water with some form of an anti-freezing agent as the medium in which they transfer thermal energy. These additives diminish the water's heat transfer capabilities to around 40-50%. Utilizing the ethylene glycol solution improves this transfer capability by about 20%.
   - The coil array is 10% more efficient than a typical flat plate heat exchanger. The array utilizes a double header, thick, wide-spaced, fin design that maximizes counter flow. It also offers a small air-glycol approach temperature to maximize heat transfer. (Figure 4)
   - From a maintenance perspective the entire depth of the coil is accessible for ease of cleaning**.**

2) **Piping/Flow Configuration**
   - Traditional runaround uses 1 or two units on the loop with constant flow of heat transfer fluid
   - This uses a **Gang system** (Figure 5) that allows multiple exhaust units on one loop with control valves at each unit. This allows for variable flow to optimize heat transfer between exhaust and glycol solution. The

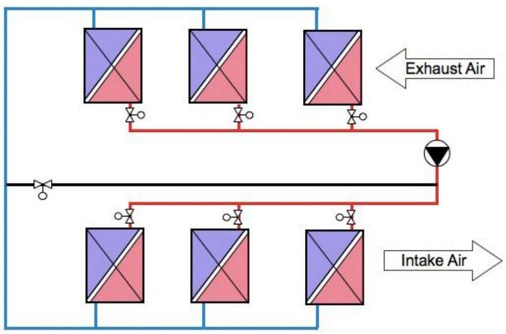


Figure 5: Konvekta "Gang" configuration
www.konvekta.ch

centralized pumping system then takes all of this pretreated solution and distributes it to the OA units for preheating/cooling in the same manner.

3) Control System

- These controls match delta T between OA and EA with the variable flow valves at each unit in order to optimize heat transfer performance with glycol solution.
- Integrates with air handler controls for variable air flow across coils as well in order to match ventilation requirements.
- Assesses real time energy savings in addition to having pressure drop alert systems for potential leakages etc. (Ethylene glycol has less chances of leaking due to its viscosity and surface tension)

Overall this system allows for a heating energy recovery of about 65% (with the pool, 60% without). As the school is primarily being used in the heating season, this will provide tremendous savings to the owner and community in lifecycle costs.

3.2 Heat Recovery Rationale

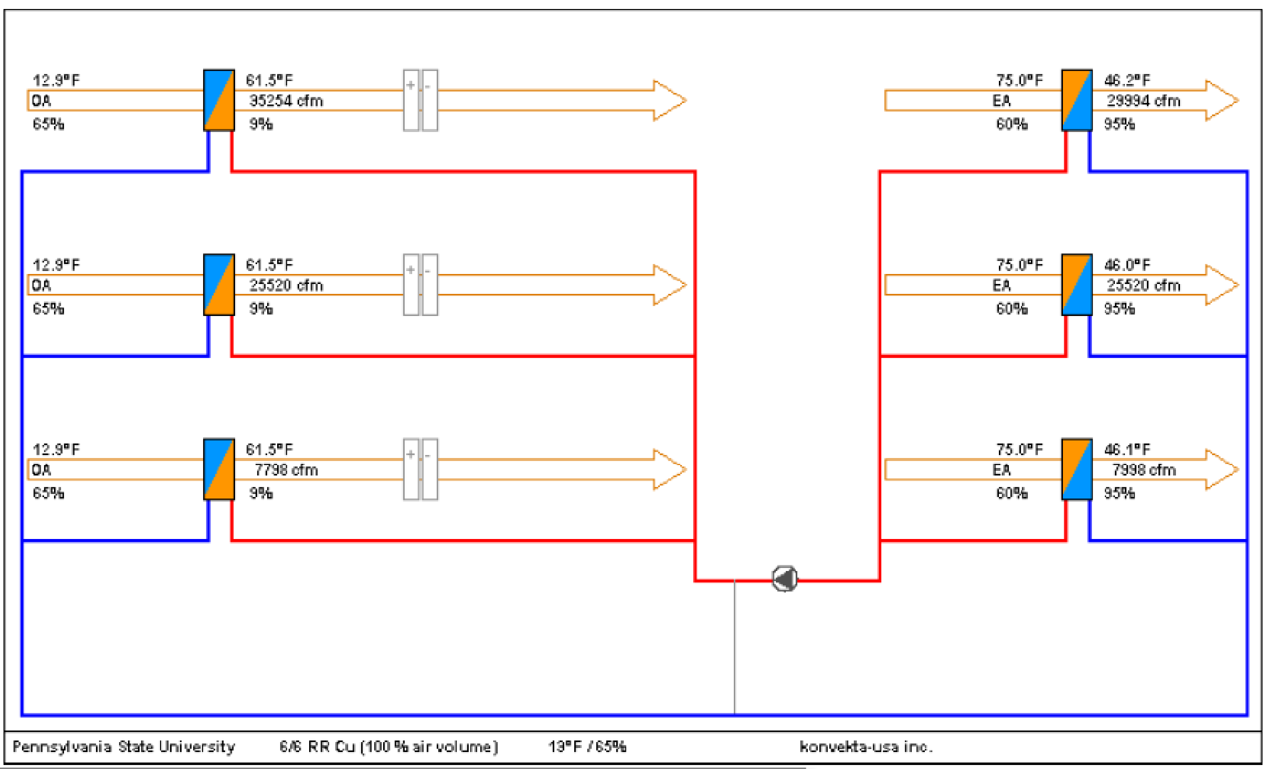


Figure 10: Air handler Runaround configuration at 100% Air Volumes