AFFORDABLE SUSTAINABLE DESIGN FOR A RURAL HEAD START SCHOOL IN DAYTON, OREGON

Michael Eichman, Ted Nickell, Kathi Futornick,

Michael Eichman, Executive *Director*
Head Start of Yamhill County
P.O. Box 1311
McMinnville, Oregon 97128
Phone: (503) 472-2000 ext. 312
Email: mikee@headstart.oregon.com

Ted Nickell, Owner
Ted Nickell Design & Build, LLC
P.O. Box 724
Amity, OR 97101
Phone: (503) 835-3402
Email: tednickell@msn.com

Kathi Futornick, *Director*
LEED Accredited Professional
Environmental Consulting
Associates, LLC
14800 N.E. Bluebird Hill
Dayton, OR 97114
Phone: (503) 864-2936
futork@onlinemac.com
www.environmentalconsulting.us

:

ABSTRACT

Head Start of Yamhill County, Oregon completed construction of a "super-insulated" energy efficient "green" Head Start facility in Dayton, Oregon. Head Start utilized innovative funding approaches and design techniques to work within federal and state program requirements. The monitored results indicate that the facility has achieved its stated goals of energy efficiency, high quality indoor environment, and lowered operational costs. Its lessons learned have been utilized in design and construction of its newest facility in Sheridan.

TABLE OF CONTENTS

About Head Start

The Head Start Program is a national comprehensive child development program that serves children from birth to age five, pregnant women and their families. It is a child-focused program designed to increase the school readiness of children from low-income families. Head Start began in 1964 when the Federal Government asked a panel of child development experts to draw up a program to help communities meet the needs of disadvantaged pre-school children. From its inception to the present time, the Head Start Program has been enthusiastically received by childhood development specialists, communities, educators and parents across the country. The Program has a long tradition of delivering high quality services in the areas of education, early childhood development, medical, dental, mental health, nutrition, and parent involvement. The program is administered by community-based non-profit organizations and school systems. Many consider the Head Start Program the number one federally-sponsored success story of our time.

Head Start of Yamhill County receives public funds as well as private donations. They operate with efficiency and strong fiscal controls. Historically, Head Start classrooms have been located in church basements, gymnasiums or donated buildings. Use of existing and donated structures was the quickest way to set up programs and avoid construction costs as long as operating/maintenance costs of the spaces were low. The conditions of such classrooms varied but many often produced discomfort from poor lighting, minimal heating, poor air circulation, indoor toxins including asbestos, and "background noise" from unrelated nearby activities.

Many Head Start Programs in Oregon and in other states continue to be located in such facilities. However, the Head Start Program of Yamhill County looked at the long-term impacts of such environments and believed, that with local support, they could better manage operational and maintenance costs while improving classroom conditions. Head Start of Yamhill County was determined to better meet the needs of their children with the construction of a well-designed building.

Innovative Approach

Head Start of Yamhill County's innovation is two-fold: (1) partner with local donors and community leaders to supplement federal and state grant dollars to construct Head Start facilities which are owned and operated by Head Start as a non-profit; (2) utilize state-of-the-art environmentally sound technologies to optimize long-term operations based on energy efficiency and a healthy environment.

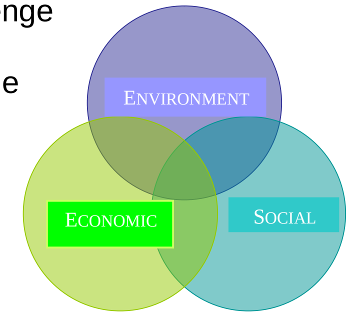
Head Start of Yamhill County contracted with a local builder, *Ted Nickell Design and Build* to design and construct a new school for Head Start in July 2000. The school was constructed in Dayton, Oregon, a small rural agricultural community southwest of

Portland. Form and function of the school were integrated into the design with specific environmental features incorporated into the building structure as well as surrounding site. Head Start collaborated with its staff, design professional, experts in energy efficient building, and with stakeholders to ensure that the design of the school reflected its commitment to a successful learning community.

In keeping with Yamhill County Head Start's policy of "continuous improvement", the school's operational efficiency was evaluated and areas for improvement were incorporated into the design for future buildings. Subsequently, Head Start schools constructed in Sheridan, Oregon and one to be constructed in Newberg, Oregon have benefited and will continue to benefit from these improvements.

Key Issues

The key issues for Head Start are social and economic. The challenge for Head Start of Yamhill County is to fulfill, and where they can, exceed, the social and economic requirements of the program, while minimizing impacts to the external environment and improving the quality of their internal environment. Therefore, for Head Start to achieve a sustainable program, they must find a way of meeting all three objectives.



Head Start's direction is clearly established in its bylaws and by the Federal Head Start Program. It is within these parameters that Head Start of Yamhill County must operate. Therefore, Head Start of Yamhill County formed long-term relationships with its stakeholders to underscore the successes of the program and identify its limitations. The limitations were clearly the result of a poor "physical" environment and with external assistance, could be overcome. Over a ten-year period, Head Start of Yamhill County began to inform stakeholders of potential solutions and eventually relationships became partnerships, and with the help of the federal grant authorities, state authorities, and the local community, including private donors, Head Start's Board of Directors established a budget of $180 per square foot and authorization to begin design and construction, once funding was firmly in hand.

Integrated Design

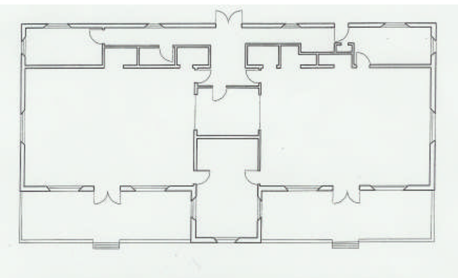
The design for the Dayton, Oregon Head Start facility began many years before the year 2000 when Head Start began laying the ground work to secure funding for a new facility. It began during the years the classes were held in church basements, storefronts, and makeshift buildings; where heavy rainfall would flood basements, where mold would grow on walls, where lighting was dim, and where children had to wear warm clothing to cut the chill from drafty environments. It began when staff, parents, and administration of the Head Start program started to say, "there is a better way" to embrace our children in a positive learning environment.

It was Michael Eichman's strength of conviction that a positive learning environment meant healthy air for children to breath, natural daylight to nurture a growing mind, warmth to ward off a cold, and bright spaces to celebrate their development. He had long been interested in environmental design, the works of Christopher Alexander, and green building. It was Ted Nickell's pragmatism that brought together the ideas of parents, Head Start staff and Michael Eichman into a workable solution. With Head Start's conceptual design of a simple one-story building, staff and parents began laying out key spaces, important features and they began visualizing movement through these spaces.

Ted Nickell integrated a structural framework to support the concepts. His first decision was to form a super-insulated shell with no thermal bridges. Although concrete would be used as the main building material, the building would be seen as a "traditional design".

THE DAYTON HEAD START BUILDING

The Head Start building located in Dayton, Oregon was constructed in July 2000 and is a 3,500 square foot, one story, type 5N composite insulated concrete and wood framed building with a UBC occupancy of E-3. It is a single story rectangular building with the long dimension oriented east-west for optimal solar gain. Even though both its heating and cooling system are small in comparison to the size of the building, operational records and design features classify the facility as "super-insulated" and "super-ventilated".



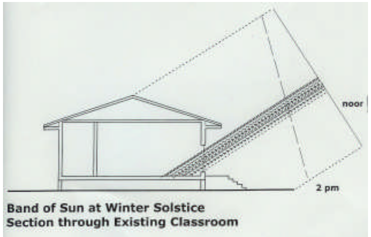
Existing Plan: DG-B1 LCR=101 SSF=19

The design of the facility supports 8 rooms with the two largest rooms (one on the east and the other on the west) servicing child-development needs. The support rooms are located along the north side of the building and include teachers' offices, teachers' preparation area, parents' room (with a one-way interior window glass to observe the child development rooms), a conference room, kitchen, storage rooms, mechanical room, entry, and bathrooms. The kitchen is located in the northeast corner of the facility and receives maximum morning light from north and east facing windows. The children's bathrooms are in a semi-private area of each development room.

Energy Efficiency

The key environmental issues include both energy efficiency and interior air quality.

The *energy efficiency* of the building has been achieved through a systematic approach to building design. The most important component in the building is the Heat Recovery Ventilation system (HRV). Additionally, a key component in the system is the "highly" insulated shell with no thermal defects. Energy efficiency is further supported through airtight ductwork, conditioned spaces where HVAC equipment is located, solar orientation, super insulated windows, and long eave overhangs.



Band of Sun at Winter Solstice
Section through Existing Classroom

The long-axis of the building runs east and west with south glazing and roof overhangs to supplement and enhance the passive heating of the facility. Most of the windows are located on the south side and are classified as "super windows". The four-foot eave overhangs help keep the summer sun from over-heating the child development rooms.

Since the classrooms are for three- and four-year olds, the foot-deep south window sills are 10 inches off the floor. Therefore, there is a need for the floor and window areas to provide thermal comfort for the children.

A major contribution to the efficient heating of the facility is in the construction of the Dayton building. To optimize energy, the foundation is constructed from expanded polystyrene (EPS) insulating concrete forms (ICF's) for the footings and the walls, from the ground to the roof. The EPS, rated at R 10, was placed under the basement slab to disconnect the concrete from the ground, decrease thermal loss, and thereby completely encapsulating the building. The building's weight is borne by high density extruded polystyrene (XPS, 60 psi) insulation under the insulated footings. High density foam insulation (Poly-Form) was placed under the foundation footings completely isolating the concrete from the ground and thereby preventing thermal loss or fluctuations and decreasing moisture problems. This step decreases temperature fluctuations in the insulated concrete cores that could be created by changes in ground temperature. The footings and the walls are reinforced concrete contained in the ICF's. Three inches of EPS is added to the outside of the ICF's in order to increase the R value of the ICF resulting in a total R value of R30. An additional layer of exterior insulation brings the R value to R 42. By encapsulating the concrete in the ICF, the beneficial thermal mass effect of the concrete is heated by internal air. The concrete retains the heat and reduces fluctuations in indoor air temperatire (Delta T). The only vapor barrier used is located below the basement slab.

The roof is insulated (the ceiling is not insulated) and there is no ventilation in the roof system. The roof is composed of two-layer EPS panels. The roof panels rest on top of the framing system, not in-between framing members. The roof trusses have no rafter tails, thereby preventing framing members from penetrating the insulation and increasing thermal bridging. The panels which cover the roof are similar to Structural Insulated Panels (SIPs). However, the Dayton facility has placed the two-piece panels on top of the trusses, thereby avoiding any thermal bridging.

A "crawl space" beneath the building is an insulated mini-basement just four feet high with pipes, ducts, water heaters, furnaces, fans and ventilators located in this conditioned space. Therefore, with the equipment located within the insulated building envelope, heat is retained and not lost.

The HVAC system is small and arranged in two zones. Each zone has one Seisco tankless electric water heater which supplies hot water to two fancoil units from Vent-Aire. Vent-Aire also supplies the heat exchanged for the integral HRV system, and the cold water chillers that cool the building. The chillers utilize refrigerant from one 5-ton compressor. The blowers run continuously while the building is occupied resulting in no thermal stratification. The air-tight HVAC ducts are not insulated and therefore radiate heat to help warm the floor. All ducts are inside the insulated envelope, including the ductwork for the heat recovery ventilation (HRV) system. Return air ducts are located in every room. Rounded, rubber-gasketed ducts are run entirely within the insulated envelope. There is no insulation, tape or mastic used. When SMACNA tested the ducts for leakage, they were found to leak less than 1%

The attic is ventilated, heated and cooled the same way the 4-foot basement is conditioned. Using these techniques, the envelope for the building shell is rated at R 30 and based on test results from Oak Ridge National Laboratory, may be as high as R 42.

The building is mechanically ventilated by a system of pumps that continuously replaces old air with fresh air from the outdoors. The system combines full-time heat-recovery ventilation with space heating, space cooling, and water heating. Two tankless Seisco electric water heaters provide the hydronic heat.

The suspended wood floor is warm because it has no insulation. It is warmed from below by non-insulated ductwork and plumbing. Temperature differential between the daylight hours where activity and use of the building is high, and the evening hours, where there is minimal to no activity, was within 2 degrees. An incredible achievement considering ambient temperature between daylight and evening hours can be as much as 40 degrees.

The building shell was completed with super windows with a U value of 0.24, R 10 doors and acrylic stucco. The floor was finished with commercial grade wood veneer throughout and no wall-to-wall carpets were installed - only a few area rugs. Rugs were selected based on materials that reduced toxins and allergens since the children often use the rugs for rest and play. Paints were used with low VOCs (volatile organic compounds) and the wood floor finish was pre-finished to prevent off-gases from emitting toxins into the interior of the classroom.

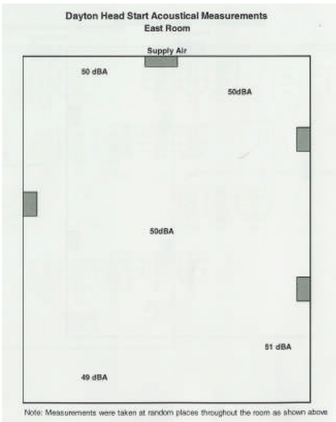
Monitoring

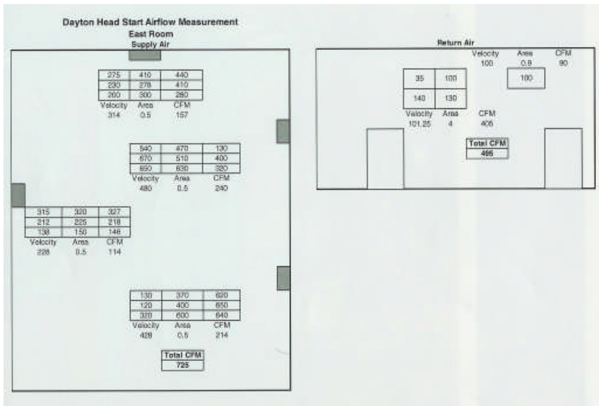
The facility was monitored by several sources including Oregon State University Extension Service, University of Oregon Architecture students, Indoor Air Quality Research Collaborative, the Oregon Office of Energy, the Bonneville Power Administration Super Good Cents Program, and professional testing firms.

The University of Oregon Architecture students focused on passive solar heat. The use of passive solar heat has transformed from the early 1960's as a primary heat source utilizing thermal mass concepts to a secondary heat source, with the use of ICFs and SIPs. After their evaluation, it was clear that the solar gain had to be carefully "regulated" in order to not overheat the building. The building was performing as designed, and even better when it came to energy efficiency.

With respect to the ventilation system, the Oregon State University Extension Service monitored carbon dioxide levels. The indoor air was in a range of 15 to 20 cfm per person in each room. Ted Haskell of the OSU Extension Service stated in his March 5, 2001 memo, "This is exactly the type of system and performance level that has been targeted by standards organizations for years. If it were considered a prototype for future system, that would be a very good thing."

The indoor Air Quality Research Collaborative monitored indoor air quality in general, and specifically air flow and acoustics. The results are:





Cost Savings

The additional construction cost compared to a similar sized facility built to meet Oregon building code requirements was $18 per square foot ($63,000 in increased costs for the entire facility). This increased construction cost was more than off-set by increases in electric rates of 51% and 24% increases in natural gas rates. By building a super-insulated facility, Head Start of Dayton saved 30% of their overall utility bill in the first year and made improvements to increase that savings to 50% in subsequent years. They accomplished the additional savings by eliminating one the 5 ton coolers, by not heating the kitchen since the super-insulation more than adequately warmed the kitchen. These extra savings alone resulted in a less than 2-year Return on Investment.

LESSONS LEARNED

With the success of the Dayton facility, Head Start completed construction of its Sheridan facility in 2004. The building was sized at 4000 square feet compared to Dayton's 3500 square feet, and modifications were made to its HVAC system as well as its conditioned crawl space. Monitoring will also be conducted at this facility. During the design phase of the third facility for Newberg, improvements will be based upon these monitored results.
Like the Dayton facility, the Sheridan facility is located in a small agriculture-timber dependent community, located within City limits, and on land classified as in-fill.

The Newberg facility, located in commuting distance to Oregon's largest city, Portland, will be constructed on donated private land and be the "cornerstone" or magnet facility for the eastern part of the County. It most likely will serve a larger number of children and their families than either Dayton or Sheridan, and will incorporate external site standards such as stormwater management and water use.

NEXT STEPS

Head Start of Yamhill County entered the LEED EB pilot program and is currently pursuing LEED certification. Head Start of Yamhill County recently retained Environmental Consulting Associates, LLC, a local environmental and LEED accredited professional to assist with the process. Certification under the LEED program will further confirm the "added value" of building green as well affirm that public programs within strict budget guidelines can cost-effectively build "green".