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Bullitt Center Challenges Built Environment

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Continuing to Evolve

Evolution of the ground-source heat pump industry must be constant to assure long term success. Innovation of design and implementation of the technology is required to evolve the industry.

This issue of Geo Outlook features four articles on innovative design and implementations of GSHP technology to achieve superior results. The Bullitt Center in Seattle, Washington, (the greenest commercial building in the world) is actually a net producer of energy built with “state of the shelf” to achieve “state of the art” design and implementation. Two university implementations highlight innovative designs to strengthen growing trends of building or retrofitting GSHP systems in educational buildings. Skidmore College of Saratoga Springs, New York, adds four existing buildings to geothermal through the implementation of a shared system to reduce the size of the ground heat exchanger. The University of Findlay of Findlay, Ohio, has implemented a system that has received the 2014 ASHRAE Technology Award in Educational Facilities – New Construction. This article touches on the highlights of design and implementation. More information can be found at www.greensleevesllc.com. The fourth article involves an old friend to IGSHPA. The Charles Machine Works Ditch Witch Division of Perry, Oklahoma, is one of the seven charter members to form IGSHPA. They have remained a valued supporter and partner to the practical research efforts for drilling and trenching. Their article documents the retrofit of its Product Development Center and their innovative design to solve the issue of lack of open space for the bore field. Our Industry leader article is on Jay Egg of Egg Geothermal. His experience started at age seventeen and continues with consulting, speaking and publishing today.

IGSHPA enters a re-design phase after 27 years of existence. An organization retreat was completed in mid-May that mapped out an overall strategy that will culminate in an organization retrofit by year end. We examined all aspects of what we do and how we do it with the end result of exceptional service to GSHP industry. Re-design did not stop in May and we will continue to evolve through innovation.

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Jay Egg Promotes Geothermal From Experience

By Kaylie Lathe

Jay Egg

“It’s wonderful to be involved with geothermal cooling and heating,” Jay Egg says. “All good attributes, all the time.”

Egg is the owner of Egg Geothermal, a geothermal consulting company based out of Florida. He is also the author of several books, blogs and articles promoting geothermal. Egg brings the enthusiasm and belief in the technology needed to deliver geo to an under informed world.

Egg began his career at the age of 17 as a commercial electrician in California before joining the Navy as a nuclear electrician. The Navy’s two-year training program in Orlando is what first brought Egg to Florida. After spending two years in the Navy, Egg moved on to a new venture. He began working with a company that managed the maintenance for Wendy’s stores. Egg soon realized first hand the special concerns for commercial air conditioning in Florida’s hot and humid climate. He attended a technical school to become certified as an HVAC technician.

By the age of 25, Egg had become the statewide service manager for Taylor Freezer, a division of the Carrier Corporation. During that time, he was also pursuing his contracting license. It is then that Egg was initially introduced to geothermal without any idea how his future would be tied to the technology.

An equipment failure on his own AC unit caused Egg to experiment to make his system more efficient. After a successful experiment, Egg decided to pursue similar research and discovered the International Ground Source Heat Pump Association. Egg immediately enrolled in a class and was eager to learn more about ground loop technology.

In 1990, Egg brought his newfound information back to Florida and began a geothermal focused contracting business called Egg Systems, Inc. Egg also worked with others as an HVAC contractor. One of his notable accomplishments at that time was assisting an electric company in giving rebates for geothermal heat pumps, an uncommon practice at that time.

In 2009, a new challenge was presented to Egg when one of his customers came to him seeking assistance in getting federal tax credits for the geothermal he installed in his home. Egg was skeptical of this possibility, but agreed to help if he saw proof that geothermal tax credits existed. Sure enough, the American Recovery and Reinvestment Act of 2009 provided just this and Egg immediately went to work. He had an entire new website built focusing on geothermal and it wasn’t long before he was being featured on new installations on the local news stations.

Egg found his love of writing about geothermal when an unexpected note from McGraw-Hill landed on his desk asking him to write a book.

“I left the note there for almost a week thinking it was a hoax,” Egg said.

Egg finally called Judy Bass, the editor for McGraw-Hill Professional Publications, and by the end of the conversation, Egg was set to write a handbook on geothermal. Egg teamed up with Brian Howard Clark, a writer for Hurst Communications. Together they worked for 10 months and by early 2010, they had finished “Geothermal HVAC: Green Heating and Cooling.”

The success of the book was immediate and it was not long before McGraw-Hill asked Egg to write an engineering level book on geothermal.

Egg’s second book, “Modern Geothermal HVAC: Engineering and Control Applications,” went into more depth than his first, providing technical information on geothermal.
Greg Cunniff of Taco Residential and Commercial Hydronic Systems and Carl Orio, founder of Water Energy Distributors and an IGSHPA Certified Instructor and Certified Geothermal Designer, were brought in to co-author the book. After 18 months of work, the second book was finished in 2013. Egg has received good reviews for both books.

“The first book got a lot of comments on how readable it was and the second one was very technical so we’ve had incredible reviews from engineers across the nation and world,” Egg said.

Writing these books led Egg into many speaking and consulting opportunities as an expert in the industry. He enjoys writing and speaking and likes to promote the industry. In 2010, Egg sold off Egg Systems Inc., and started a geothermal consulting company, Egg Geothermal. These days, Egg spends his time consulting, speaking and writing.

Egg’s first column was “10 Myths About Geothermal,” for National Geographic’s website. After great success with that article, Egg now not only writes for National Geographic on a regular basis, but for various other online and print publications including Green Builder, Commercial Building Products, Plumbing and Heating Contractor, and Plumbing Engineer.

Egg consults for clients and governments all over the world. He speaks and makes presentations at conferences and events, including IGSHPA’s annual conference. Egg has also had the opportunity to be part of a two-hour training class as a geothermal expert on a panel at AHR Expo in New York City. He also speaks regularly for the National Ground Water Association.

Egg believes the future for geothermal is bright. He believes the possibility of geothermal heating and cooling becoming a standard for new construction is closer than ever before.

Egg will continue doing what he enjoys: promoting the industry and educating others by sharing his knowledge and enthusiasm through consulting, speaking and writing.

Jay Egg and Joe Potter together on the site of the Pinellas County Emergency Operations Center, an $84 million, 3,000-ton geothermal 911 center and police station in Largo, Florida. As Operations Director at Land Lease, Potter oversees one of the world’s largest construction management firms. (Photo provided by Jay Egg)
Bullitt Center Challenges Built Environment
By Janet F. Reeder

The Living Building Challenge clock started ticking at the beginning of 2014 for the Bullitt Center. Considered by many as the greenest building on earth, the Bullitt Center is designed for net-zero-energy and net-zero-water.

(Photo by Ben Benschneider)
In 1970, Denis Hayes climbed up on the stage in Central Park and stood before a million people who had convened for the first celebration of Earth Day. Now more than four decades later, Hayes, the first national organizer of Earth Day, is helping spearhead another movement. Hayes, as CEO of Seattle's Bullitt Foundation, extends that early environmental concern and focus to helping cities learn and choose to become sustainable.

Seattle's Bullitt Center, the foundation’s new six-story office building, has set a new mark in the realm of sustainable commercial building. Hayes, the man responsible for the vision to move forward to this important point, spent a lot of time setting this latter stage. The Bullitt Center project appears to be a perfect extension of the shared philosophies and mission held by Hayes and the Bullitt Foundation.

“Originally endowed with an extravagant abundance of natural biological capital, the Northwest United States and Southwest Canada – the region known as Cascadia – is at an inflection point in its history,” Hayes says. “Following more than a century of intensive exploitation of its natural resources, Cascadia is now turning green. It is restoring its abused landscapes, and it is on the cusp of becoming a global model for a new approach to human ecology.”

The Bullitt Foundation seeks to catalyze the necessary changes to expedite that effort.

“After seeing how the Bullitt Center performed in its first year, I’m certain we will be net positive energy, not just net zero. If we can do this in cloudy Seattle, owners in other cities should be embarrassed if they don’t achieve zero net energy,” Hayes says.

Hayes hopes the structure itself and the efficient building strategies it entailed will become a challenge and a resource to the building industry, not just in the Northwest U.S., but the world.

Saving energy at the Bullitt Center can involve taking the glassed-in stairs that offer a scenic view of downtown Seattle. Tenants have energy budgets that are intentionally set for keeping within the net-zero energy rating.

(The photo by Nic Lehoux)
To that end, extensive information about the design, materials and technologies incorporated into the Bullitt Center is available on the building website (www.bullittcenter.org). Throughout construction, the Bullitt Center team documented lessons learned and is openly sharing these with the building community.

Since the Bullitt Center is the first urban infill commercial building to seek the Living Building Challenge (LBC) certification, it is pushing the leading edge of performance-based design, Hayes says. The LBC is a philosophy, advocacy platform and certification program that defines priorities on a technical level and as a set of core values. The LBC is also the most rigorous benchmark of sustainability in the built environment.

Exceptional planning and teamwork started long before ground was broken on the project. Hayes and the Bullitt Foundation carefully chose project partners.

Craig Curtis, a partner at the Miller Hull Partnership, the Bullitt’s architect, has said that early on Hayes shared with him that in the end the highly efficient building still needed to be a place where people would want to work and spend time. Brian Court, also of Miller Hull, shared project design with Curtis on the Bullitt Center.

Paul Schwer, president of PAE Consulting Engineers, the Bullitt Center’s primary mechanical-electrical engineer, has said many of the sustainable technologies and materials in the project are better described as “state-of-the-shelf” rather than state-of-the-art” for what is turning into a remarkable building.

Geothermal work started with drilling contracted to GeoTility, a company that serves Canada and the Pacific Northwest. The borefield to support the hydronic radiant heating and cooling system consists of 26 boreholes drilled to a depth of 400 feet. All of the borefield work is under the footprint of the structure.

Hydronic radiant heating and cooling is used throughout the building, utilizing the floor mass of special slabs.

(Photo by John Stamets)
PSF Mechanical’s Project Executive Robert Willis says that the system is really straightforward. For educational purposes, the mechanical room has glass walls. It is one of the most popular things to see on tours.

“That’s our work for the most part,” Willis says, of the mechanical room. PSF did all the inside geothermal installation. “We are getting a lot of comments on the workmanship,” he said. “We are very, very proud of it.”

Bullitt’s climate control system uses natural ventilation and an automated high performance curtain wall system. A German manufacturer partnered with Everett, Washington’s, Goldfinch Brothers to bring fabrication, distribution and installation of Schuco products to the U.S. A heat-recovery ventilator kicks in when seasonable temperatures are too hot or cold for the window operation.

Engineer of Record, Conrad Brown with PAE, a Portland, Seattle and San Francisco based engineering firm says PAE created the building heating and cooling control sequences to include control of the windows and shading systems, since these building elements function as part of the building’s comfort control system. “The radiant heating slab’s primary function is for heating. But since the slab is connected to heat pumps we are able to chill the slab and produce coincident cooling also,” Brown said.

PAE was already in the process of opening a Seattle office, and since the completion of the Bullitt Center was on a very similar timeline, they were able to move into the sixth floor. “It is really an amazing building,” Brown says. “It has been a really great success, so we are very proud of it.”

Brown worked with Justin Stenkamp and Marc Brune, both PAE project engineers, from the early stages of the design process when energy analysis began.

“We primarily used eQuest for the energy analysis, but also utilized other software packages to help inform the design. The software allows the user to build a geometrically accurate building, including all the internal energy
using systems like heating, cooling, ventilation, lighting, internal plug loads and apply scheduling,” Brown said.

“The results from eQuest provide a detailed output showing the amount of energy being used by the lights, heating, cooling and building plug loads. We then analyze the information and focus on areas of building energy use that could benefit from our attention,” Brown said.

“Because our goal was net zero energy, we had to calculate accurate energy use predictions,” Brown said. “The size of the photovoltaic array was directly proportional to the amount of electricity the building consumed on an annual basis,” Brown said.

“The project team spent a significant amount of time planning the building and related systems on the Bullitt Center because the goal was to create a net zero energy and net zero water usage building,” Brown says.

The geoexchange system in the Bullitt Center consists of four WW120 FHP heat pumps, and one WW240 FHP heat pump used for the domestic water.

“It is a closed loop system with the FHP water-to-water pumps,” Stenkamp says. “Three heat pumps provide heating or cooling water to radiant floors through a seasonal change-over loop,” he says. Stenkamp says the borefield’s 26 wells come into the basement to five separate headers, with five wells on each header except for one with six.

“The system was designed to provide all heating and cooling with the geoxchange system. There is not any additional heat or cooling source,” Stenkamp said. He says that the geothermal system has a “significant impact” on meeting LBC energy requirements.

“A geoexchange system was chosen because it is three to four times more efficient than a comparable non-fossil fuel system,” Stenkamp says. Having the geothermal system helps to reduce the building heating energy to a very
small percentage of the anticipated energy use. Interestingly, plug loads and computer usage are bigger energy contenders than the geothermal system.

“What we are finding as we look at projects with very aggressive energy goals is that you are almost required to move towards a geothermal heat pump based system,” Stenkamp said.

Stenkamp’s new office in the Bullitt Center also allows him to show off the project to engineers, architects and others who come to see it. He says the response to the building is very positive.

“I enjoy giving tours to professionals and communicating the lessons we learned on this project so it can be applied to other projects,” Stenkamp says.

When that happens, it will make a full circle for Denis Hayes.

“One building off by itself has zero impact on the world’s climate, but a building that is influential and begins to change the way that architects, engineers, contractors, developers and financial institutions shape the built environment, that’s a building that was worth building,” Hayes said.
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Davis Building Garners ASHRAE Technology Award  By Janet F. Reeder
The University of Findlay's new science building has far exceeded typical energy savings using Greensleeve’s GeoModule™ control software, winning the 2014 ASHRAE Technology Award in Educational Facilities–New Construction.

(Photo courtesy of The University of Findlay)
Designing a university science building has its own challenges. Designing that building to attain more than 50 percent energy cost reduction is almost unheard of. Science buildings with their multiple fume hoods and high ventilation rates are often the highest net energy consuming buildings on a campus.

Administrators at Ohio’s University of Findlay saw that challenge met and then some with a recent $11 million addition to the university’s Davis Street science facility.

The University of Findlay is the largest private college in Northwest Ohio, with a student population of nearly 4,000. Its 78-acre campus is located in Findlay, Ohio, and offers nearly 60 areas of undergraduate study.

The Davis Building was completed in 2012 and provides a 42,000-square-foot addition of science classrooms and related spaces including 26 laboratories.

Both Findlay’s Martin Terry, vice president of business affairs, and Myreon Cobb, director of Findlay’s physical plant, understood the long-term energy cost of a campus science building when they began planning.

The University of Findlay’s challenge to achieve energy efficiency and state-of-the-art clean tech operation with a high return on their investment fell in the right hands.

After the project team from RCM Architects and Greensleeves LLC completed multiple energy simulations to quantify energy savings options for the buildings components, including wall construction, windows, roof insulation, lighting and others—the feedback led the team to a number of sustainable solutions.

In the end, the GeoModule™, an intelligent hybrid geothermal control software system developed by the Greensleeves team, lead by Shane Mason, P.E., drove those solutions.

The specialized software allows the ground-loop field to be monitored and controlled for optimized performance of the geothermal system designed for a project.

The Davis Building system has no individual heat pumps. Instead a SMARDT® nominal 60 ton capacity heat recovery chiller with a magnetic bearing compressor is used with R-134a refrigerant. The building’s thermally massive radiant cooling system and active chilled beams can use fluid directly from the geothermal loops for cooling without engaging the chiller operations. Hamstra says this is the first implementation of the heat recovery capability of the SMARDT® heat recovery chiller in this configuration of geothermal HVAC application.

Hamstra, chief technology officer at Greensleeves at the time of the project, is now president of Greensleeves, with offices in Ohio, Michigan and Florida. Hamstra, a Professional Engineer,
ASHRAE Certified High Performance Building Design Professional and Certified Geothermal Designer, has extensive geothermal design experience.

With the introduction of the Geo Module™, Greensleeves intelligent optimization software, the Davis Building’s first year energy costs were reduced by an estimated 57 percent and the maintenance costs for the same time frame were reduced by 35 percent. This is equivalent to approximately $83,000 of energy savings per year along with an estimated $7,500 in maintenance savings. The system also eliminates more than 800 tons of carbon dioxide in addition to reducing sulfur dioxide and nitrogen oxide.

Hamstra has recently won the 2014 ASHRAE Technology Award in New Construction of Educational Facilities for his work on the project. ASHRAE selects exemplary projects each year and this is a global honor that represented project entries from all over the world. This was the only geothermal HVAC project to win a First Place ASHRAE award this year.

The design of the HVAC system developed in parallel with the architectural design process. The final envelope design consisted of high mass walls of concrete blocks with sand-filled cores enveloped with exterior insulation covered with architectural metal. The HVAC system design leveraged this insulated thermal mass in a way that actually let the interior absorb heating and cooling loads and time shift peak loads by several hours.

The geothermal heat pump energy plant consisting of the magnetic-bearing chiller, pumps, variable speed drives and controls were factory assembled at an ISO-9001 facility and shipped to the site on structural supports for site assembly. Breaking the system down this way allowed moving it into the 6-foot wide doors of the mechanical area. This significantly reduced construction and commissioning time as well as risk related to varying on-site conditions and quality control.

Tom Holmes and his crew from Jack’s Heating and Air Conditioning in Findlay were charged with reassembling the heat pump plant when it arrived in skidded units. Holmes, who has done other work for the university, says that the system is working well for them.
“I know they have been really happy with the operating costs, comfort and the efficiency. And I understand they may be considering doing another building,” Holmes said.

The central heat pump system uses a 60-ton magnetic-bearing chiller, selected for its ability to allow an innovative method of coupling the sensible cooling devices directly to the geothermal earth heat exchanger. This central plant simultaneously makes hot (95 degree F) water and chilled (45 degree F) water. Hamstra says the chiller supplies hot and cold water for the radiant heating, the radiant cooling and the active chilled beam system.

“Our technology is really based on managing the geothermal borefields so that they can become smaller, more cost effective and more efficient,” Hamstra said.

The Davis project has 30 boreholes drilled to 350 feet by Midwest Geothermal’s Scott Skoog. The borefield is configured with three headers piped separately to the mechanical room with 10 loops on each. Piping was 1-1/4 inch HDPE U-bends with a total bore-footage length of 10,500 feet. A 400-foot test bore resulted in 2.13 Btu/ft-hr. during thermal conductivity testing.

“We have three separate borefields there that we manage the heat flux in and out of the system so that we can keep some of them cooler or warmer with our controls,” Hamstra says. “And the reason we do that is for the active chilled beams and radiant cooling where we only need 58 degree chilled water. Because the deep earth temp there in Northern Ohio is around 52 to 54 degrees, we can make that 58 degree water just by turning a circulating pump on from the borefield.”

Hamstra says that is also where the project gets the high EER numbers of 150-200 for that portion of the cooling load, instead of the 15 to 20 EER of an air cooled chiller. That is a 10:1 ratio, he says.

“We handle as much of the cooling load as we can with that and the chiller...
only comes on to handle the rest,” Hamstra said. “The other part of that is that this is a 42,000-square -foot building and we are cooling it with the 60-ton chiller. So that is unheard of small.”

Figures from Hamstra show the project’s HVAC—all of the indoor equipment, the controls, the borefield—all in, was done at about $30 per square foot.

“That is very cost competitive with conventional systems like VAV, boilers and chillers. And it is also very cost competitive with regular geothermal with water-to-air unit heat pumps and a borefield,” Hamstra says.

“But the reason that happened is that with our control technology, a lot of things were able to be smaller,” Hamstra said. “So having smaller equipment and a smaller borefield, we reduced the first cost which allowed us to put money into control technology and intelligent controls.”

Hamstra explains that with three different borefields, the system can dump the heat from the chiller into one. Plus with the cooling tower on a closed circuit, Hamstra says that it can cycle on at night if the system shows run time is needed. The system auto-adapts, he says.

“We also run that in the winter to precondition the borefield because the building has so much more cooling load than heating load. Our system does an energy simulation every five days in the control system,” Hamstra said.

The system can figure out how much it should run the cooling tower in the winter to balance out the loads for summer, he says. As far as he knows, no one else is doing this type of technical application where the controls are automatically adapting the operation of the geothermal borefield based on real building performance data.

The project has garnered attention from professionals in the industry. Hamstra, who has also been made a Distinguished Lecturer by ASHRAE, has speaking engagements booked for several months. He is also presenting at the ASHRAE National Conference in Seattle in June.
Ditch Witch Operation Adds More Geo

By Kaylie Lathe
A view of the Charles Machine Works Inc., shop where Ditch Witch equipment is made.

(Photocourtesy of CMW-Ditch Witch)
Perry, Okla., may not be where you would expect to find the headquarters for a global company, but it is there Ditch Witch® equipment manufacturer, The Charles Machine Works Inc., began and still operates today.

Walking into the front office, a row of flags representing all the countries CMW does business with greets you. When you first enter the plant, you see the machine displayed that started it all and a large wall collage. As you look at the many photographs that make up the collage, you begin to get a sense of the family and community values the company was built on.

The Charles Machine Works, Inc., also known by the brand name Ditch Witch®, is a leader in manufacturing high-quality underground construction equipment. In addition to revolutionizing the way underground utility services were installed, Ditch Witch® also formed a strong relationship with the geothermal industry.

The horizontal drilling and vacuum equipment are frequently used in geothermal installations, including those on the CMW campus. The Ditch Witch® Training Center, built in 1992, was the company’s first geothermal project, followed by the Subsite® Electronics Building in 1997.

CMW’s third and newest geothermal project involved a retrofit of its Product Development Center. The 28,800-square-foot structure was built in 1978 and is the campuses’ only retrofit.
The Product Development Center was unlike the other projects due to the large, open space that would need to be cooled and heated and the lack of space available for equipment. Principal Plant Engineer, Tony Guinn, knew single units would not be plausible.

“Our first units were individual classrooms made up of individual units with individual fields, kind of like residential,” Guinn said. “We didn’t have the space to do individual units for this project so we were looking to condense.”

Darrel Stolhand of Stolhand Heating and Air of Ponca City, Okla., found the solution with ClimaCool’s SHC onDEMAND® Modular Chiller.

A four-pipe system comes from the mechanical area to serve the Product Development Center.

(Photos courtesy of CMW-Ditch Witch)
“I’d been to training with Air Products Supply and was highly impressed with the unit’s ability to generate heating and cooling simultaneously,” Stollhand said. “Also, the comfort level of this type of system is exceptional, especially when considering the design of the building, which includes two levels of an open floor plan and a south-facing wall made entirely of windows.”

Three of the 50-ton units take up little space, while cooling and heating the space efficiently. The units are forced air and utilize R-410A refrigerant. A small, exterior metal building was built near where the chillers once stood to house the units, piping and controls. A cooling fan runs in this area to keep the units from overheating in the confined space.

With CMW always looking to expand its 23-acre campus, the borefield location had to be chosen with care. The area around the water tower was the perfect location and use of the space. B&H Construction of Goldsby, Okla., drilled 126 vertical boreholes at 400 feet and 42 at 300 feet. One-inch U-bend pipes were placed in each of the 400-foot boreholes, while U-bend pipe of different size and construction was placed in each of the 300-foot boreholes for testing purposes. The building is now running on half of the borefield while the remainder is still being used for testing.

B&H Construction has been using Ditch Witch equipment for 35 years, but this was their first project on the campus. Senior Project Manager, Scott Munday, recalls how smooth the project went.

“The borefield was laid out and designed when we got there and the engineers at Ditch Witch did it very well,” Munday said. “They were great to work with.”

The biggest benefit CMW has seen from its geothermal retrofit of its Product Development Center is the low maintenance.

“Maintenance wise, I’ve done nothing,” Guinn said. “That other unit always had something wrong with it. I don’t have any problems now. That’s been the biggest benefit.”
Simple adjustments made in controls of the system early on were the only “problems” that have been experienced, Guinn explained.

“The system would shut down,” Guinn said. “It was looking for pressure differential and if it didn’t see a pressure differential it was thinking the pumps weren’t running so it wouldn’t start. The pumps were reacting too fast. We added some delay time so when the valves opened up, the pump revved and the units said ‘ok now there is flow’.”

CMW’s own Ditch Witch® trenching and vacuum equipment was used in their geothermal installation.

B&H Construction out of Goldsby, Oklahoma, handled the grouting for the project. (Photo courtesy of CMW-Ditch Witch)
A massive vault was needed to bring the borefield together and create the manifolding system needed.

(Photo courtesy of CMW-Ditch Witch)
Their equipment is commonly used for other geothermal installations around the world.

CMW has expanded beyond the compact trencher that started it all. Today, the product line of underground construction equipment is extensive including, trenchers, vibratory plows, pneumatic piercing tools, backhoes, electronic guidance and locating tools, horizontal directional drilling systems, drill pipe, downhole tools, vacuum excavation systems, excavator-tool carriers, and mini-skid steers.

Ed Malzahn, only 28 at the time, developed the first compact trencher for laying underground water lines in residential areas. The invention led to the compact trencher industry.

Today that industry manufactures equipment for underground utilities including water, sewer and gas lines, telecommunications, CATV and fiber-optic cables.

CMW was built on the values Malzahn learned from his grandfather, Carl Frederick Malzahn, who moved his family to Perry in 1902 and started a blacksmith business. Today, CMW still embodies those values, placing a high importance on family and community.

Malzahn also learned how to adapt business to changing demand as his grandfather’s blacksmith business transformed into a repair shop called Charles Machine Shop to serve nearby oil fields. Malzahn saw a need and with a degree in mechanical engineering and family background of hard work, he created a company that continues to be a pioneer and leader in the industry he created.

Chairman of the Board, Malzahn has seen his granddaughter, Tiffany Sewell-Howard, become CEO of the family enterprise. Even though Malzahn no longer wears the title of CEO, he still keeps a close eye on his company, arriving before anyone else and leaving long after everyone else has gone.

Three 50-ton ClimaCool SHC onDEMAND® Modular Chiller units handle the heating and cooling in a minimum amount of space. (Photo courtesy of CMW-Ditch Witch)
Editor’s note: Charles Machine Works has a long and important history with IGSHPA. One of seven charter members to start the association, CMW’s Ditch Witch® equipment grew its geothermal interest alongside the new association. Phil Albertson, an OSU graduate in industrial engineering, and engineer for CMW, worked closely with Dr. James Bose in developing IGSHPA. Albertson was the original designer of the increasingly popular slinky pipe configuration. He was named an IGSHPA Ambassador in 2005.

For a company that values innovation, geothermal fits perfectly. For years, CMW has worked with IGSHPA to promote geothermal and Malzahn still recognizes the importance of geothermal to the Ditch Witch brand today.

“The industry has been good to us,” Malzahn said.

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(Photo courtesy of CMW-Ditch Witch)
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Arts Quad Benefits from Geothermal District System

By Paige Worley
The Arthur Zankel Music Center was the first building of the Arts Quad to be retrofitted with a ground-source heat pump system.  
(Photo by Sam Brook)
The goal to make Skidmore College in Saratoga Springs, New York, 50 percent geothermal by 2020 has required creative thinking.

The university began working on its first geothermal project in 2005 on the new Northwood Village residential apartments. The apartment complex houses up to 400 students. The next project was the Murray-Aikins Dining Hall, a facility large enough to seat 700 students. With the completion of the $2 million project on four Arts Quad buildings Skidmore has 640,000-square-feet geothermal usage. More than 35 percent of campus is heated and cooled by GSHP.

A new district system connects all four Arts Quad buildings. The system design included 84 boreholes, drilled from 400 to 500 feet each. Without it, a typical building-by-building design could have required 125 to 130 boreholes.

The latest project on the Arts Quad section involved buildings more than 40 years old. Arthur Zankel Music Center, Filene Music Building, Janet Kinghorn Bernhard Center and the Saisselin Art Center make up the Arts Quad. Geothermal retrofit on the buildings started with Zankel in 2007. Zankel was completed in 2009 and retrofit of the others began.

Earth Sensitive Solutions LLC., created the district system that allows the buildings to share and shed the heating and cooling loads. In the case of the Arts Quad, three buildings are heating dominant and one is cooling dominant.

Jared Fortna, senior engineer at Earth Sensitive Solutions LLC., worked on connecting the other buildings to the district system. His challenge, he says, was the distance between the buildings.

Barney & Sons from Laurens, New York, drilled boreholes for the project. In total, 84 boreholes were drilled.

(Pho**t**o **courtesy of Earth Sensitive Solutions)

“It stretched our brains to think a little differently to get it all together, but that’s part of it, to do something different and see it work,” Fortna said.

(Phot**o by Sam Brook)

(opposite) The south side of Zankel has an amphitheater for campus events.
Engineers used hydraulic separation on the project, Fortna said. The hydraulic separation lets the individual buildings pump fluid to heat pumps on an as-needed basis. Fluid goes into the heat pump and acts like any geothermal system. However, while fluid is at the node it shares its energy with other buildings. This keeps EERS and COP more favorable, he said.

“If the fluid at the node gets too cool or too warm, the loop field pumps kick in to move heat out to the loop field,” he said.

These loop field pumps are 1-3/4 HP ECM pumps. The system starts with one pump that can increase speed from 900 to 3,300 RPM. As the fluid temperature gets colder or warmer, pumps are added to share the load. The pumps reduce speed and the amount being used as they respond to the node fluid and reach the desired temperature, Fortna said.

“When buildings are sharing energy, the main pumps do not use more than 200 watts,” Fortna said. “It’s enjoyable to see very little energy being used to get the job done.”

Mike Hall, director of financial planning and budgeting for Skidmore, put together the sustainable energy plans for the college. The school received an $800,000 grant from New York State Higher Education Capital Matching Grant Program. The school was directed to use the money toward non-residential facilities.

Earth Sensitive Solutions created the temperature control and pump staging control algorithms that were used in the control system. TBS Controls developed the code and the hardware.

(Photo courtesy of Earth Sensitive Solutions)
buildings to make sure we were thinking the right way,” Lundberg said. “There was a good coordination effort.”

Lundberg expects a maximum eight years to see a return on the investment. The buildings were not individually monitored for energy usage beforehand, so administrators like Hall and Lundberg will look at the overall energy costs and the changes overtime. In the future, he expects to see considerable energy savings.

“It didn’t cover all of the costs,” Hall said. “But, it was a foundation for the project.”

Skidmore provided a match to the NYSHE CAP grant from the college’s normal capital budget process. New York State Energy Research and Development Authority and National Grid are committed to providing incentive funding for the projects. No amount has been determined.

Paul Lundberg, assistant director of construction services, was in charge of putting the elements of the project together with vendors, engineers and college finances. His biggest challenge was the infrastructure and underground work. “The campus buildings are situated on top of dolostone rock with minimal overburden. This rock is very dense and presents problems going laterally below freezing levels. But it is a huge factor in Skidmore’s geothermal success as this hard material has a great thermal coefficient, one of the best when utilizing a vertical bore field system,” he said.

“The problem is when you go six feet down laterally in this stuff, it’s really hard to get through it,” Lundberg said.

“It’s good boring down and it is terrible going sideways for lateral supply and returns.”

For this project, engineers were strategic in node placement. The team found a central location for the node “to talk to the other buildings,” he said.

“We did extensive modeling on these buildings to make sure we were thinking the right way,” Lundberg said. “There was a good coordination effort.”

Lundberg expects a maximum eight years to see a return on the investment. The buildings were not individually monitored for energy usage beforehand, so administrators like Hall and Lundberg will look at the overall energy costs and the changes overtime. In the future, he expects to see considerable energy savings.

“Now we have high efficiency systems in these buildings that had old legacy systems,” Lundberg said. “It works great.”

A large amount of piping was involved in tying the heat exchange field to the system.

(Photo courtesy of Earth Sensitive Solutions)

(opposite) Loop field group piping is located in the energy node building.

(Photo courtesy of Earth Sensitive Solutions)
Art students and environmental studies students have designed 22 posters to educate students and visitors on environmental projects. Two of the posters highlighted geothermal energy. The campaign is meant to help students visualize the technology and learn more about its impact.

“Our students are getting more aware of what we have done and are understanding the systems a little bit better,” Lundberg said.

Karen Kellogg, associate dean of the faculty for infrastructure, sustainability and civic engagement said the project is ongoing. The posters rotate around campus every three months.

The posters are a way to bring attention to environmentally friendly practices such as GSHP. It allows more than the students that benefit from the technology to understand it and learn more. Students and faculty that have used the classrooms during and after the retrofit project, are happy with the results, she said.

“It’s working really well,” Kellogg said. “It’s a comfortable environment.”

With the Arts Quad completion, Skidmore is moving toward its 2020 goal. It is considering geothermal for a new science center, said Daniel Rodecker, director of facilities services. Learning from the Arts Quad project helps plan future projects, he said.

“We did learn new pumping strategies,” he said. “And that installing a district system allows you to take advantage of the diversity of the loads.”

Geothermal helps the university reach its ultimate goal, a reduction in its carbon footprint.

“We haven’t really begun to plan beyond 2020 yet, but sustainability and reducing our carbon footprint is very important to us,” Rodecker said. “We look at all projects individually to see if they make sense from both a sustainable and a financial sense.”

Editor’s note: Skidmore College has begun work on a second geothermal energy node on campus since contacted for this article.
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Let me explain.

We are primarily competing with DX split air conditioners/furnaces or air source heat pumps, boiler/tower water source heat pump systems, and boiler/chiller systems – all with outdoor equipment. This outdoor equipment is subject to life cycle and performance degradation by the extremes of weather and the local environment, as well as vandalism, theft, and any number of other negative occurrences that can and do have an impact on any outdoor equipment. Also, they all require regular maintenance and upkeep. Some require preventative maintenance measures and/or refits to stay in reasonable working order. All have median useful lives of from 10-25 years (depending on system type) per the ASHRAE 2011 HVAC Applications Handbook.

Their equipment gets old, so does ours. Mechanical equipment breaks, so does ours. But, GSHP units have an estimated useful life of approximately 25 years – as long as or longer than our competitors per ASHRAE as noted above but with better efficiencies and without preventative maintenance or refit. So, we live longer, perform better, and provide a life cycle cost analysis result that is second to none.

The GSHP can be replaced and still use the same loop – this replacement costs about the same as a conventional system. In this marketplace there are some buildings with GSHP systems that are being demoed and replaced – and use the previously existing ground heat exchanger to serve the replacement facility. Good stuff, but there’s more.

The competition takes outdoor condensers, cooling towers and boilers, or air cooled chillers and boilers which cost money to replace when they come to the end of their useful life. They require outdoor utilities, safety enclosures, and are noisy and unsightly. The ground heat exchanger is concealed underground, does not wear out, or have a limited useful life – there is NO replacement capital investment required.

The key issue is MAINTENANCE. Forget the equipment and pumps inside the building and think about the ground heat exchanger buried in the earth – out of site with nothing exposed to the ravages of outdoor surface or rooftop mounting. As mentioned previously, the pipe to fabricate the ground heat exchanger is guaranteed by the manufacturer for 50 years, but has a useful life typically in excess of 100 years. So, in a long-term building, possibly 4 or more generations of GSHP units can be served by the existing loop. The ground heat exchanger is the system’s condenser, cooling tower and boiler, or air cooled chiller and boiler. The ground heat exchanger doesn’t require any replacement or MAINTENANCE for a service life of 100 years or more.

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Mr. Rawlings has more than 35 years experience in the geothermal industry. He is the Director of Geothermal Services for Trison Construction, a Certified GeoExchange Designer (CGD) and an IGSHPA Accredited Installer and Trainer.
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