Two Year Old Pool's Utility Costs Slashed 50% or $50,000 a Year

by Bill Holmes, P.E.

Just a couple of years before we signed a contract to manage the energy systems in a 20 building school district, there had been a major expansion project at the oldest high school, one that had been built in the mid '50s. An indoor pool, auditorium and gym had been added. It was a nice addition for the students and the community. A local architectural firm had been selected to design the additions and they turned out to be practical, functional and fit in well with the style of the original building.

New addition adds $100,000 to annual utility costs

As we started gathering historical records from the utility companies for all 20 buildings, it was immediately obvious that the new addition had increased the annual utility costs for the high school more than $100,000. I don't know if projections had been made or not but when I started talking to various people in the schools they seemed shocked to find out what the actual numbers were. In looking at all of the systems, operation and other factors, it was obvious that most of the increase had come from the pool. I believe the local architect had hired a mechanical & electrical (M&E) engineering firm from Indianapolis to design the energy systems which was standard practice. They were nicely designed systems with the equipment in separate, accessible rooms. The M&E firm was obviously concerned about energy because they had included a system in the pool to recover heat from the exhaust air and recycle it back to the pool.

What they hadn't done however, was to provide a heating source separate from the rest of the building. My guess is they might have proposed one and may have even done a preliminary design but it was not included in the project. I believe the first bids had come in over-budget and been rejected. It's a fairly common occurrence. But when that happens, the design professionals have to then go back through the project item by item and decide what they can eliminate or modify to cut the first cost so it can be built. Because those choices often come down to architectural changes that would affect the appearance or function, and mechanical or electrical changes that no one will see, those systems are often compromised. As a general rule, well-designed, efficient, easy to maintain systems, located equipment rooms will last 30 or more years but are expensive to build. Owners, when faced with getting something built or not, are put in a

really tough situation and quality M&E systems are the first to take the hit. Look around at newer buildings; look on the roofs and you will see them covered with cheap, packaged rooftop units. That's all the budget will support. Low first cost but very expensive to own and operate over the life of the building.

The new addition did have a large rooftop unit to provide air condition for the auditorium; the rest of the school wasn't cooled at that point, but the equipment for the pool was all in nice mechanical and electrical equipment rooms. We started immediately to install some sensors and examine the actual equipment as well as the original design. It was a process of establishing priorities; starting with the most expensive schools and systems first and working down to the least. We had to start finding opportunities and creating savings from day one; a share of the actual savings was our only source of income. Audits, studies, designs, estimates, capital projects were not part of what we did; we had to produce, verify and document actual savings every month to get paid that month.

Heat recovery system was off

The first thing we found was that the Heat Recovery System was turned off. When we tried to turn it on, it wouldn't run. In the few years since the system had been installed, the filter had never been cleaned. Everything in the unit was plugged with dirt, the filter, the heat exchanger, and the actual fan blades were so caked with dirt that even if it could run, it wouldn't move any air. Why, when this system had been put in to save maybe 40% or 50% of the very substantial cost of heating the fresh air that was required by health codes, wasn't it being used? There are a number of very real-world answers. It was another of those ideas that looked good on paper but failed miserably in the field.

The first problem was it was mounted near the ceiling and to even get to the unit a long ladder had to be brought into an equipment room with very little space to maneuver and put in an exact position. It was really tough to get to; we did it but I had some young, athletic employees. Plus I doubt that anybody had ever even explained to the maintenance staff why the unit was there and what preventive maintenance was required. Simple as it seems, studies have shown that one of the leading causes of mold in schools is lack of the most basic maintenance – changing filters and cleaning drip pans and other areas where water collects.

Design problems uncovered

Once we got to the unit, restored it to its original condition, we found that the ductwork and control system wouldn't really work they way they were installed. The pool had one giant air handling (fan) unit that was designed, as are most HVAC systems, for the worst-case design conditions which might happened one day a year, every other year or not at all. And this fan had no recirculation from the pool area. It was bringing in 100% outdoor air, heating it up to 82-84 degrees, as required for public pools and then exhausting it all; very, very expensive. And it was doing it 24 hours a day whether there was anyone in the pool or not. There were no provisions for reducing the amount of air and the heat required under less than worst case conditions. **That was where most of the extra $100,000 was going!** Plus, in the winter, all of the cold outside air was dropping the humidity in the pool are below 30%, which, the way I read the codes was a violation.

Health code requirements

I was not going to take any chances with the health of students by making any changes at all before thoroughly researching codes and pool requirements but I knew there had to be a number of options. Otherwise there wouldn't be a pool in the country that could afford to remain open. As luck would have it, a childhood friend Richard Scott was one of the leading pool and aquatic facility designers in the country. Richard and I had gone through every class together from kindergarten to graduation, through Air Force Officer Training School together and had stayed in touch over the years. I sent him some of the results of my research and my thoughts on opportunities to cut utility costs. Within a short time when he came to visit family in the area, we went to the Pool. He confirmed my thoughts. The huge fan was bringing in amounts of fresh air greatly exceeding health requirements and actually lowering the humidity below legal limits. The heat recovery unit had a smaller fan that was still large enough to bring in and circulate enough outside and return air to satisfy all code requirements and cut the energy requirement dramatically. We had to modify the original controls but after that was done, the humidity rose to acceptable levels, 40%-50%, and the gas consumption dropped by about half

Concerns about our changes

Although I had grown accustomed to some people getting upset every time anything was changed, for any reason, I have to admit I was surprised by some of the reaction to these

changes. After all, I had brought in one of the leading pool designers in the country for advice on the pool and he had worked with me to improve the quality and efficiency at no charge. When we were done, from both continuous monitoring of the conditions with our AutoPilot system along with daily personal visits by my employees (our office was only four blocks away), it appeared that everything was running as well as it possibly could.

The first and most obvious problem was purely psychological; the huge fan had been noisy while the smaller one was very quiet. When someone who was in the pool enough on a regular basis to notice how quiet it was, they immediately assumed that fan had failed and everyone in the area would be immediately asphyxiated. I don't know how many calls our office received. We would call up the pool on our computer, make sure everything was working properly, that all of the temperatures and humidities were where they should be and then assure the caller that everything was fine. Often, we would send an engineer over to check, just to be sure.

Scoreboard was rusting

Then I got a call from the Assistant Superintendent. He had a received a call from Bill the Athletic Director saying that our changes were running his scoreboard; it was rusting and going to cost him a fortune to repair or replace. When you walked into the new addition, if you happened to look up, there were big letters that said "Bill ***** Athletic Center". Bill had been a star athlete in at the school many years before, played basketball and baseball at nearby Indiana University and returned to coach at his Alma Mater where he had coached several No.1 and undefeated basketball teams over the years. When Bill spoke, everyone listened. I setup a meeting with him and listened to his concerns. He was the nicest person you could meet.

What I learned was that the scoreboard had some age on it; it was not new when it was installed. It was rusting and would need to be replaced before long and the money would come from Bill's athletic fund, not the school's maintenance budget. Before the meeting I had called the company who made the scoreboard and they had told me it was designed to be installed <u>outdoors</u>. The 40-50% humidity in the indoor pool was not a problem. The real problem was that it had exceeded its life expectancy and it was time to be replaced. Shazam! I had found the real problem; it wasn't really the changes we had made but where the money to replace it would come from. I explained to Bill what I had learned from the manufacturer and I am sure he thanked me for my

time and effort. It seemed to always pay to meet with people face to face, head off the rumors and solve the problem on the spot.

Record cold snap exposes wall construction problem

Soon after we had made our changes the temperature dropped to minus twenty during an unusual December cold spell and stayed there for several days; very unusual for Central Indiana. Thank goodness for Global Warming; without it the temperature might have been forty below. After a couple of sub-zero days, very large ice cycles started to form on the bricks on the outside of the building. The schools called the building's architect to see what the problem was. He came, looked at the building and announced that the ice cycles were caused by the changes we had made in the pool operation; we were going to ruin his beautiful building. He cited some codes that we were violating when in fact, we had corrected some initial violations through the changes we had made after consulting the pool expert. The building's architect was local, a friend of mine and a good architect; he had done some very nice work in the community. But the key word is "Architect". Architects have enough training in mechanical and electrical systems to be dangerous but generally leave most of those details to the mechanical & electrical (M&E) engineering firms they hire.

I knew it wasn't anything we had done and in this case my friend should have known better, too. This was a building designed to house an indoor pool. We had monitored data showing the indoor humidity stayed between 40-50% as required for indoor pools. That wasn't the problem. The problem was with the vapor barrier in the walls. They had either been designed or constructed improperly. When it is humid and warm on one side of a wall, there's a high vapor pressure, and when it is cold and dry on the other, there's a low vapor pressure. The result is a tremendous pressure trying to drive the vapor, or water into the walls. The walls should have been designed and built with a vapor barrier such that no significant amount of water should have been able to penetrate them. And for any small amounts that did, they should have an escape route so the moisture could get to the outside without damaging the bricks. Wall design for pools in Canada and colder climates is an exact science, but the Midwest doesn't normally experience such severe temperatures and something had gone wrong. We hadn't done anything to cause it. Maybe the schools should have called Al Gore to complain.

Thoughts on pool heating system

Whether the engineer for the new addition had designed a separate, independent heating system for the pool or not, I am betting they did. But it didn't get built. And the result was that when the pool needed heating during the spring and fall, for both the water and the air, to be usable and satisfy code values, the central heating plant for the entire campus, two giant steam boilers had to be fired. The school could remain comfortable for two or three weeks in both the spring and fall without firing the boilers. The lights, people, computers, etc. provided enough heat. So for 4-6 weeks a year, two giant steam boilers were run for a new pool that had been built with no independent heating system.

The Head of Maintenance for the schools was a tremendous person to work with and completely understood the problem. When we recommended adding some stand-alone modular boilers in an equipment room in the new building, he asked us to put together a preliminary design and cost estimate. Our estimate showed that the school would have saved enough gas to pay for the new pool heating system in one spring or fall period. As far as I know they never did it. They couldn't get the money to improve the heating system but somehow they found a way to keep sending that check to the gas company every month. That wasn't the schools' fault though. It was the way the school funding laws in Indiana were written. There were so many time I was so glad I wasn't in his shoes trying to do a job the best he could with both hands tied behind his back.

One final complaint

The first summer after we had made our changes, there had been a swimming meet and I got another call from the Assistant Superintendent. This time with a complaint from a parent about how unbearably hot it had been in the pool for a swimming meet. Excuse me? This was Indiana in the summer. The pool wasn't air conditioned. Our records showed it was in the mid-90's outside and the upper 80's inside. We had run the ventilation system full out during the night to bring in the cooler outside air and pre-cool the pool area and then reduced the ventilation to the minimum amount when it got hotter outdoors that indoors. ***Sometime I thought my brother who has his PhD in psychology was a lot better suited to deal with the problems I encountered some days than I was with my engineering degrees.***