Excuse Me, I Didn't Realize that Physics Was a Democracy

By **Bill Holmes, P.E.** July 27, 2012 02:24:02 pm

Those words just popped into my head as I sat at the conference table in the boardroom of a regional hospital when George, the hospital administrator, went around the table asking everyone in attendance whether I had made a serious error in my redesign of the air conditioning system for the emergency rooms. The rooms were overheating and the modified system couldn't cool them. I don't think the words I was thinking actually came out of my mouth, but I was hot (not from the temperature – the conference room was at 72 degrees). I was in a room full of angry people trying to defend myself. The assistant administrator, the business manager, the medical chief of staff, the head of nursing, the head of facilities and two board members agreed that I had made a mistake. I was outvoted.

Back when I had set the goal of becoming an expert, of knowing more about how buildings and energy consuming systems work than anyone else (and I had succeeded, I did know more, at least more than any of the other people in that room), I had neglected to consider one small fact. That fact was, once I knew more than those I was dealing with, I sometimes found myself all alone. I had to defend myself against every "that's not the way we have always done it" or "anybody knows you can't do that" or "Billy Bob, our night custodian says you can't turn that pump off. All of that stopping and starting will wear it out and cost a lot more than the energy you can save."

This was the 1980s, the newspapers and magazines had been full of stories on how to save energy for 10 years. Everyone seemed to know more than I did from reading those stories. Looking back on the situation, it strikes me as pretty ironic that during the 1980s, the staff in a medical facility, from reading articles and watching TV programs, would be telling me how to conserve energy, and now I can watch a drug ad on TV and tell my doctor what she needs to prescribe, even if she went to school for 13 years to become an expert in one specific area and has been working in her specialty for 20 years.

But at the time it wasn't funny. I was in the position of having to defend myself and my engineering. I was outvoted. I was sitting in the boardroom with all these people thinking that I had a theory about how to keep the emergency wing cool and it wasn't right. It didn't work. It was just a theory. It might be right and it might be wrong. Either that or I had screwed up big time.

I had reduced the airflow provided to those areas from an excessive amount to the actual requirement according to my engineering calculations. I had replaced an oversized fan motor with a smaller one, a sound technique to save energy but one that flies in the face of accepted maintenance practices. Ed, the head of facilities, said to the group, "Anyone knows that if you are going to replace a motor you always go to the next bigger size; you never put in a smaller one." George said, "Just admit you made a mistake and we'll deal with it."

Of course, I had made mistakes before – the only way to avoid mistakes is to never do anything, and I had admitted them and dealt with them. But I had checked and rechecked every part of my design and calculations and was sure I hadn't made a mistake when I replaced the motor. Something else was going on. But at that point, those people didn't care about theory or calculations. They just wanted their ER cool and I didn't blame them. I had to do some problem-solving, find out what was wrong and fix it, and fast. Oh boy, Houston, we have a problem! Now the fun begins!

Luckily for me, also at the table was Harold Pardieck, the mechanical contractor who had made the modifications to the mechanical systems. As we were discussing the situation, I had explained that the parts of the emergency wing that were experiencing the problem were interior spaces, they were

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Bill Holmes, P.E. founded Holmes Energy LLC www.holmesenergy.com and developed the AutoPilot Monitoring-Based Commissioning (MBCx) System in 1979. He has a B.S. and M.S. in mechanical engineering and has done additional coursework and research for his PhD. He is a former Purdue professor and taught for several years in the Continuing Education in Energy Management Program at the University of Wisconsin.

Bill has produced savings from 20% to, in a few projects, more than 50% from low-cost, no-cost changes in management, operation, maintenance and control alone in all types of facilities including Industrial Plants owned by Fortune 500 Companies.

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surrounded by other air conditioned rooms. The patient rooms above and the offices and labs on either side were always 72 degrees. The air supplied to the rooms from the ventilation system was cool. Those ER rooms had no walls or roof exposed to the outdoors. So how did they know what was going on outside? How did they know if it was hot or cold? Why were the ER rooms too warm?

At this point, when the group was just about ready to order a rope and load me in an ambulance headed for "Hangman's Crossing" (only about two miles away, where vigilantes hung the Reno brothers after they committed the first train robbery in U.S. history in 1866), Harold said, "You know, Mr. Holmes has a good point. I agree there is something else going on." Harold was this crusty, wiry older guy who grew up in his family's local heating and air conditioning business. He had spent his whole life making things work, solving problems and keeping people comfortable. He knew the theory, too. I loved working with people like Harold; they were all about working hard and getting things done. Generally, they hated sitting in meetings, they wanted to be down in the boiler room welding pipe.

But Harold seemed comfortable talking to this group in the boardroom. He had probably installed the heating systems in a number of these people's houses as well as their parents' houses before them. This was a million dollar project and he wanted everything to be perfect. He had never given a single indication of resenting me as a young engineer with more book knowledge than he had, but not even in the same universe in terms of field experience. We both knew that a successful project needs both the theory and the practical and we had worked together very well.

The next question, as always, is, "Okay, suppose you are right, there is something else going on. What is it? And how can you fix it? We need those rooms to stay cool." Good questions, really good. What would my problem-solving mentor Bob Kotnik do, what would his approach be? Just then I had a flashback to my first thermodynamics class during my sophomore year in college, when Professor Steinhauser uttered the five words that changed my life, that have been etched in my mind ever since: "Heat In equals Heat Out." The first thing I learned, the same thing my students who worked for the nuclear plant had to account for every day.

When people are too hot, they automatically think they need more cooling. In this case, they had been cool, I had reduced the amount of cooling supplied to the ER as a part of an energy conservation project and now they were hot. It didn't take a brain surgeon to see that I had screwed up. Harold agreed to put the old larger motor back in and increase the cooling air volume until I could find the problem. I'm sure I was the only one at the table, with the possible exception of Harold, who actually believed there was another problem.

I had a friend who had paid about $15,000 for an infrared camera in the 1970s (when you could buy three decent new cars for that much money). He had a successful land surveying business and had been trying to expand into selling thermal scans to building owners. He offered me the use of his camera. I borrowed it and late one evening, took it to the ER. With an infrared camera, different temperatures show up as different colors. Cool materials are blue, warm ones yellow, and hot ones are red. As soon as I turned the camera on and looked around the area, this bright red floor jumped up at me.

As I was working, the staff was curious and asking me questions. This was a small town ER, late on a week night and there were no patients. As I explained what I was doing, the ER doctor asked if he could take a look. I handed him the camera and, of course, the first thing he did was point it at the nurse. "Oh my God, look at that," he said, after he had scanned her from her head to her toes and seemed to be focusing on an area somewhere in between. That use for the camera hadn't been in the manual.

So the floor was obviously a very effective infrared heating system and it was hot in the middle of the summer. That hadn't shown up in the original blueprints and apparently no one in the boardroom was aware of it. The next morning I came back to look more closely. There was no basement, but there was a crawl space that was about five feet high in that area. For safety reasons, the boilers were in a completely separate building connected by a tunnel with a fire door, completely isolating it from the rest of the campus.

I went across the street to the boiler house and mechanical equipment building and walked through the tunnel to the hospital. As I crouched down to enter the area under the ER, I could see a whole bunch of big pipes. As I got closer, I began to feel the heat radiating from them. I could see that not only were there pipes, there were a couple of huge steel vessels. They were heat exchangers. As got to them, I knew better than to touch one. They were really hot; about 300 degrees, as it turned out. They were full of medium-pressure steam and they were completely uninsulated.

This was the system that was heating the floor of the ER above, 24 hours a day, 365 days a year. And in order to keep the emergency rooms cool, for the more than 20 years since these steam heaters had been installed, the hospital had been providing and paying for air conditioning to remove the excess heat coming up through the floor. When I had reduced the amount of airflow and air conditioning provided to those areas from an excessive amount to the actual requirement, what the model showed, it wasn't enough to keep the ER cool. I didn't know the uninsulated heat exchangers were there. They weren't on any drawings. I had missed them. I had never been down in the crawl space. I didn't know there was any equipment down there. That is part the risk of working in existing buildings – you frequently get surprises. It's also part of the fun, finding and solving problems that everyone before you

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had missed.

The hospital had been paying all of those years to patch a problem by overwhelming it rather than understanding and solving it. At some point after those heat exchangers had been installed and the emergency rooms became too hot, one of the staff or perhaps an outside engineer had solved their comfort problem by providing more air conditioning. It had cost the hospital a lot of money, but this is the most common approach, unfortunately, and often the extent of the problem solving. If you are hot, just add more cooling; once you are cool, who cares why you were too hot in the first place. They were unaware of what had happened in the past but, at least those in the boardroom had seemed confident, the solution was to provide more air conditioning.

I doubt that they were aware that Heat In had to equal Heat Out. Ed was very familiar with the heat exchangers but I'm sure he had never even thought about what happened to the radiated heat. The problem could be solved either by removing more heat from the crawl space and ER above it (providing more cooling) or reducing the heat entering the space (insulating the steam piping and heat exchangers). Of course once some basic problem-solving techniques exposed the cause and the board members were made aware of it and presented with the solution, the hospital insulated the hot surfaces, the problem was solved and their utility costs were reduced 24 hours a day, 365 days a year.

And, oh yes, the smaller motor was put back in.

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