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INDUSTRY NEWS

Teaching Architects Building Science

When energy experts gather at conferences, they have been known to grumble that the majority of architects have an imperfect understanding of building science principles. According to this view, deficiencies in architectural education partly explain the current crop of lawsuits over ice-dams, window leaks, rot from hidden condensation, and unbalanced HVAC systems in new buildings.

Among those complaining that US architecture schools fail to provide an adequate education in building science principles are many architects, including Richard Keleher of Concord, Massachusetts. On May 15, 2003, Keleher drafted a "Paper of Concern" to the organization responsible for accrediting architectural schools, the National Architectural Accrediting Board (NAAB). Under the heading "Architects Not Technically Knowledgeable," Keleher wrote, "The [architecture] schools are not providing sufficient education in the areas of the building envelope/enclosure and the relevant building science. Practitioners in the Boston area find that their staff often doesn't understand the principles governing the design of building envelopes and the control of heat, air, and, especially, moisture (both liquid and water vapor) within buildings and across and within the building envelope. The schools of architecture should be educating architects as to the principles (technology) of building envelopes and the relevant building science."

According to Keleher, he has received "no reply, not even an e-mail" from the NAAB in response to his memo. Reached by phone, Robert Odermatt, an architect and president of the NAAB board, told ***EDU*** that he has no recollection of reading the Keleher memo. Odermatt asserted, however, that NAAB was adequately addressing Keleher's concerns. "We are quite aware of these issues," said Odermatt. "Periodically, every three years, we have a validation conference to look at the things in the NAAB criteria that should be adjusted. Obviously, those kinds of concerns were addressed at the last conference. But there is pressure that comes from the limited amount of schooling that students have. They need to study historic preservation, accessibility, codes, sustainability, as well as all of the design issues. The question is not, 'Does a subject need to be addressed?' but 'When does it need to be addressed?' We have been trying to separate what happens in school in terms of education from what happens in training, during the internship. What you have to understand is there are only so many semesters in a student's education. There is also a pressure to make the profession accessible —

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more accessible to young people — so that it does not require years and years and years of education."

Surveying the Experts

In an effort to gain perspective on the issue, ***EDU*** recently interviewed several architects and engineers involved with building science issues. In addition to Keleher and Odermatt, ***EDU*** spoke with Edward Allen, an architect and author from South Natick, Massachusetts; James Axley, professor of architecture at the Yale University School of Architecture; Mark Bomberg, an engineering research professor at Syracuse University; Eric Burnett, the director of research at Penn State's Housing Research Center; André Desjarlais, an engineer and program manager for building envelope research at the Oak Ridge National Laboratory; Barry Hardman, an engineer at National Building Science Corporation in Temecula, California; Betsy Pettit, an architect and principal at Building Science Corporation in Westford, Massachusetts; and Bill Rose, an architect and building researcher at the University of Illinois in Urbana-Champaign.

Although most of those interviewed agreed that US architecture schools should be teaching more building science, several were reluctant to point fingers. According to Betsy Pettit, most US architects are acquainted with the current trend toward sustainable design and are eager to improve their knowledge of building science. Eric Burnett was similarly loathe to cast the first stone. "It's very easy to grossly oversimplify," said Burnett. "For one thing, architectural education is not uniform across the country. It is very flexible, and goes by the will and the whim of the architecture school director. In my own interpretation, when it comes to education, all of us are deficient — anyone who works on built facilities, including both engineers and architects."

Of those who were interviewed, the most optimistic ones — a group that includes Desjarlais, Pettit, and Hardman — are those actively working to help provide architects with building science training through workshops or continuing education courses. What follows are some of the observations, grouped by topic, of those interviewed by ***EDU***.

Do Most Architects Have an Adequate Understanding of Building Science Principles?

Desjarlais: "Among practitioners and consultants, there is a lack of working knowledge of how building envelope systems perform from a hygrothermal perspective."

Axley: "It would be wonderful if every architect were a Renaissance man, but in fact people are limited. That is why we have specialists, and why we disaggregate the design process into a number of players."

Hardman: "You won't find architecture plans that go into depth on air barrier details at all. Architects do not understand the principles, and they don't have the training to understand the joining between elements — for example, between walls and roofs. You won't find a detail of how the roof connects to the wall, except perhaps for a structural detail. The question is, who should be demanding these shop drawings showing details between these areas? Architects are just not trained in these details."

Allen: "I think the average architect doesn't understand the basic principles behind keeping water out of buildings. About 50 percent of lawsuits against architects are for leaks. I just don't understand why we are graduating people who aren't competent to design details that will work."

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Do US Architecture Schools Teach Building Science?

Burnett: "Architects study the appearance of buildings but not the enclosure."

Axley: "European architecture education involves five to seven years of courses related to the profession, while in the US, architecture education requires a broad four-year undergraduate degree program which may have nothing to do with architecture, plus a three-year professional degree program. Consequently an architecture student in northern European will take more courses in building science and building technology than our students will in the US. The European construction industry is just way ahead of us in terms of the sophistication of envelope construction, both in terms of analysis and execution — that is, the quality of the construction. … But I don't think the difference between US practice and European practice is widely appreciated at US architecture schools."

Bomberg: "After World War Two, the study of building science in Europe grew very fast. Now, in central Europe and Scandinavia, I don't know of any civil architectural faculty that doesn't include building science. But we'll never get there in the US, because here there is no legislation requiring it and therefore no responsibility."

Desjarlais: "Part of the problem is that, unlike in Europe and Canada, we don't have university-level programs in building science. We just don't teach it."

Rose: "There is a small group of architects who do have an understanding of building science principles, but they have had to pick up that understanding on their own."

Bomberg: "An architecture school should have a technological studio, where for the first part, level one, you study spatial design. And then you invite a few people who are experts, who are capable of guiding the students to answer questions such as, 'Can I make this with plastic, metal, or concrete? What materials or solutions will work? What are the consequences of doing this or that?' But that is the missing part now. That is the part that architects have a great difficulty in accepting."

Allen: "I don't like the term 'building science' — I prefer 'building technology.' It's not generally taught in our schools. My impression is that very few schools teach anything substantial about the building envelope. Very few schools teach any detailing, which I think is a gross failing, because that is the one technical area where architects are expected to be expert. To me, the NAAB has really fallen short on that issue, and so have the schools. There needs to be a lot more taught on the subject of building envelopes. There are scarcely any books on the topic. I just gave a talk at the Association of Collegiate Schools of Architecture annual meeting, and I noted that, in technical areas, architecture schools teach what architects don't need to know and don't teach what they do need to know. They don't teach them anything about choosing materials in a framing system, laying out the frame of the building, detailing the frame of the building. They don't teach detailing. They don't teach much on façades. It is something that has to change."

Bomberg: "The program at Concordia University in Montreal, where I used to teach, was geared toward nonstructural building engineering. It is the only university in North America which has this profile. All of the other architecture schools focus on design, but have no clue whatsoever about the materials or the physical functions of building enclosures. In North America, architects do not like to see engineers teaching any courses in architecture school. At one point I applied for a part-time teaching position at the Carleton University School of Architecture in Ottawa, but I was refused because I am not an architect. That is part of the problem — architects do not want to open the door for engineers to be part of their teaching. But somebody who is not experienced in a field cannot provide a good overview to students of the most important elements of understanding and knowledge. Now, people who were not experts in this field sometimes give these courses."

Axley: "Architecture schools are constantly, almost obsessively, altering their curricula, to adjust to what is perceived to have become important. … What was happening in the US architecture schools from the 1950s to the current time was a systematic replacement of building technology courses with courses that relate to architecture theory, history, and criticism. In the early to mid '60s, it was typical for architecture students to be required to take three or four structural engineering courses and two courses in environmental control systems. But as these history and theory courses were deemed to be more important, the building technology courses were reduced in number."

Architectural Privilege

Rose: "The main role of architecture education is to inculcate a sense of difference and superiority. That is their principal job, to provide an identity for the group and to create barriers to any comparison to builders and engineers. What sustains the privilege is cult

behavior. Their identity isn't pegged to the failure or not of the building envelope. Because of their privileged status, their identity doesn't hinge on whether things perform well or not, and their privileged status is threatened by any requirement that the buildings achieve technical accomplishments. They don't really *mind* providing buildings that perform — they rather like it if they do — but the minute anyone says, 'You must,' they react the way any cult would react — they will cream you. Most architects don't recognize the cult nature of architecture education. They always begin with a genuflection to design, because design is identity-conferring. But these are the people who drank the Kool-Aid."

Legal Liability

Rose: "In granting the franchise for architects to be responsible for construction, the interest of the state is in the health, safety, and welfare of the occupants. But the state is dropping the ball by granting the responsibility to architects."

Hardman: "I see lawsuits almost everywhere these days. But that is the way we move in this country — that's our process."

Rose: "Legally, architects are held to the 'practice standard.' The concept is fundamental to any architect's defense against claims of damage. According to the practice standard, if the architect has done what other architects in the area are doing — the common practice — that constitutes sufficient defense. Architects' ignorance of building performance is shielded by the lawyers."

Bomberg: "An architect can hire whoever he or she wants, but ultimately if there is any failure in the building, the architect is responsible. In Quebec, that is clearly specified by law. But in the rest of Canada and in the US, as far as I know, that is not the case. If the architect is only responsible for the spatial design, then we have a situation where you can sue anybody. I am afraid that now, everyone is responsible for his or her part of the building. But buildings are complex interacting systems. It may be implied that the architect is in control, but in reality he is far from being in control. We need legislation to clarify the situation. There needs to be a very clear requirement that the architect is responsible for the functioning of the building. Then they would have to have a basic technical education."

Necessary Steps to Improve the Situation

Keleher: "Having an air-barrier requirement in the Massachusetts commercial code has had a remarkable effect. Now, for the first time, I hear architects asking, 'What is an air barrier? What are pascals?'"

Axley: "At most US schools, including the Yale School of Architecture, which is seen as a school that privileges high design, the importance of sustainable design has become more and more central to curriculum development. There has been a response to alter the substance of individual courses to meet the larger expanded problems of sustainable design."

Burnett: "The question is, how do you train the guys who are already practicing? That is an urgent need."

Bomberg: "In the 1970s in Canada, Neil Hutcheon, the former director of NRC, tried to build a program for architects called 'Teaching the Teachers.' The idea was to give summer courses for architects, to bring up the topic of building science or building physics. But he found a great deal of resistance already. He did have a couple of workshops at the NRC, but it did not fly. It was organized once or twice but it failed to draw enough people."

Desjarlais: "What we are trying to do with BETEC [the Building Environment and Thermal Envelope Council] is to establish regional building enclosure councils. Several of these now exist around the country. We want to offer this to groups of architects in other cities, but they aren't knocking down our doors to do that yet."

Hardman: "One of the things we are doing with BETEC is to organize workshops for architects called Building Science Insights. The program consists of four folks, a kind of traveling show, that will connect up with a local AIA [American Institute of Architects] chapter for a full-day conference. This is a program designed specifically for architects, to introduce them to the dynamics and physics of building science as it relates to building construction. Each workshop will try to bring in regional information as much as possible, and help bring into focus for the architects the importance of building science — to introduce scenarios of proper design, how to use different materials together, wall modeling — so that at the end of the day, we've brought forth the information that walls are dynamic and physics means a lot. We hope that the participants come away with a new understanding of how things work, that we've made them think and piqued their curiosity."

Bomberg: "What we are trying to do in BETEC is just scratching the surface and waking up interest rather than actually teaching anybody. We are trying to show

that by understanding interactions you can solve some problems faster. You cannot look at an air barrier as just an element of energy conservation; it is also connected to durability. But in planning these workshops I have had to cut out 90 percent of the critical discussion items because I don't have the time. If I had three days instead of two hours, I could go more slowly and say, 'What is my goal? How do I get there?' In a two-hour workshop, you give them ready solutions, and you give them maybe an explanation of why this solution is given. You do this because they need to get something out of it. But that is not really learning — that is acquired digested knowledge. The unfortunate part is that the workshops will not solve the problem. At best we hope to change people from nonbelievers to enthusiasts."

Desjarlais: "Four times a year we offer seminars on using WUFI [a computer program that models the hygrothermal performance of walls and roof assemblies]. We jump back and forth from boring physics lectures to showing where the button is on the computer to make this happen. About 30 people come to each seminar — usually about one-third architects, one-third consultants, and one-third manufacturers of building materials."

Pettit: "Building Science Corporation is a provider of courses eligible for continuing ed credits for the AIA. In most states, architects are required to obtain 24 to 32 continuing ed credits a year. I just taught a course called Building Science for Architects, and 100 people attended. In general, both builders and architects are clamoring for the information, as long as it is presented in ways that it can be understood."

Axley: "Some schools, including MIT and the University of California at Berkeley, have, within the last 25 years, developed specific building technology programs within the department of architecture. These programs were put in there to support the architectural design program. That has been a big shift. So, in principle, the idea is to bring in better qualified technical construction instruction to the architecture program. But at both schools the curriculum has not been extended, so the number of required building technology courses is still relatively small."

Allen: "I think we need pressure at the national level to tighten educational requirements through the accrediting board. We need better textbooks, and we need people teaching this in the schools."

Hardman: "I think that all the architectural schools need to have mandatory classes in building science — in the dynamics of a building, how a building works. We need to train young architects about the physics of a building."

Taking a Historical Perspective

Bill Rose, who has a habit of placing any discussion of current problems in a historical perspective, knows that the current lack of building science expertise at architecture firms is nothing new. In his recently published book, *Water In Buildings*, Rose quotes Max Abramovitz, the architect of the United Nations headquarters in New York, who lamented in 1949, "Actually, I am very concerned that the science of building is going to disappear. I wonder if you realize how very few men are left today who are expert in building science. They are very rare and they are passed around among the large [architecture] offices. You have to dig them out of their holes and revive them."

NEWS BRIEFS

Lennox Introduces 20.5 SEER Air Conditioner

DALLAS, TX — Lennox Industries recently introduced a new residential air conditioner, the XC21, with a SEER rating described as "up to 20.5." The XC21, which uses R410A refrigerant, includes a two-stage scroll compressor and a high-efficiency outdoor coil. The limited warranty covers most components for 5 years, except for the compressor, which is covered for 10 years. According to the manufacturer, the XC21 is "the most efficient central air conditioner on the market today" and is "thirteen times quieter than a standard air conditioner."

Residential Cogeneration Unit Announced

MEDFIELD, MA — A Medfield company called Climate Energy has announced the development of a residential cogeneration unit fueled by natural gas. Called the Micro-CHP (for Combined Heat and Power), the unit is an engine-powered generator that also provides space heat. Developed with help from American Honda Motor Company, the Micro-CHP is not intended to be used to generate electricity during the summer. When used during cold weather, the unit should provide cost savings. Climate Energy expects that one of the units could produce up to 4,500 kWh of electricity per year while also meeting the space heating needs of a typical home. Although similar units have long been available in Japan, Climate Energy is the first company to develop a residential cogeneration unit for the US market. The Micro-CHP is now undergoing field testing, and should be available for sale to