Holding a model of a timber joint in his hand, the author helps the building team plan a tricky framing joint where hip and common rafters meet.

Photos by Aaron Usher

by Doug Immel

BUILDING AN INDOOR POOL ENCLOSURE

Open Spaces and Good Ventilation Are the Keys to Successful Pool Enclosures

In designing an indoor pool, our first step is to discuss the pool-use program with the client family. Then we examine how the program might determine the structure's material make-up and heating plan.

Some clients are interested in swimming as a fairly serious form of exercise or athletic training. Their building program requires very little extra living or traffic space around the perimeter of the pool, a typically smaller structure, a simpler heating and dehumidification system, and the requisite pool cover. This type of client generally lets the building float through temperature extremes, and tends to keep the water temperature lower (65° to 75°F). The overall effect is lower heat loss, lower evaporation and humidity-control requirements, and subsequently lower energy costs (see "Staying High and Dry").

Other clients are interested in having the indoor pool area double as a recreation area and barbecue space. (We've come up with some fascinating opening-roof systems.) We occasionally include bathrooms and changing areas.

In this project, built for the Smiths, we were adding an enclosure to an existing outdoor pool, a fairly typical application. The home was fairly large and had only one bathroom. His family of four (with two very active young men) felt they were sorely in need of another bathroom, preferably a "kid's" bathroom that would free up the existing bath for the parents. We occasionally joked that the pool addition was just an excuse to get another bathroom.

To meet the needs of the Smiths, we designed a large room, which was to maintain a slightly higher than average air temperature, a tight pool covering and dehumidification program, and slightly higher recreational pool temps (about 80°F). The project was located in south-central Massachusetts, an area facing about 6,000 heating degree days.

Structural Systems

The pool-use plan plays a big role in the kind of structure we build. Truss or butt-joint, timber-frame construction can give us the wide-open space a pool enclosure requires, and we've used both structural systems, depending on the clients' preference. In this case, they wanted the traditional look of timbers.

The biggest challenge turned out to be the timber-framed hip roof, an elegant design on paper, but one which turned out to be very difficult to build. Few timber framers do hip roof structures because of the difficult joints. With the timbers themselves $5 per running foot (we had 10- to 34-foot beams), we cut with care. Many pieces had multiple cuts, and on some joints we had as many as five planes intersecting.

As we got closer to the start of construction, we realized we would need the help of a specialist to work out the geometry. A timber framer developed three-dimensional models that showed all the cuts, but even when working with the joint model at our side, it was slow going (see Figure 1).

Our theoretical calculations had gotten us in the ballpark, but warped and crowned timber made field adjustment necessary. When we finished with the frame, we felt as if we'd graduated to the major leagues of timber-framers, and the pace of the job got back to normal. (Next time, we'll stick to a straight gable roof.)

We are constantly searching for materials and systems that can speed up construction of indoor-pool structures and give high insulating values and air-tight-

ness. We now rely almost exclusively on stressed-skin panels.

The panels we use have an outer sheathing of oriented-strand board (OSB), an expanded polystyrene (EPS) foam core, and a structural OSB interior panel. We add a final interior face of moisture-resistant (MR) drywall. The system provides us with several other benefits besides high R-values. The panel system has a very swift installation time. Typically, we frame houses in six to seven days (one of those days with a crane). The houses are skinned in two; doors and windows are installed in two more. Panels provide a system that is so airtight it's unhealthy (we take care of this with ventilation); they give door and window openings with extremely close tolerances; and finally, because of their structural capabilities, they allow us to significantly reduce framing. This gives us complete design freedom for interior wall locations.

The panels for this job were produced by Remarc, of Plymouth, N.H. The panels have a patented carpenter-ant repellent—Cedarfoam—mixed in the foam, and they are designed for quick assembly. (With these and other panel systems, it's important that the joints be well sealed to keep inside moisture from leaking into the seams and condensing.)

For the roof system, Remarc recommended that we install 1x10 tongue-and-groove, V-groove paneling on top of the timber trusses and install the foam-core panels over these. We prefinished the ceiling paneling before installing it (see Figure 2).

Figure 1. *"Measure twice; cut once" takes on a new meaning with heavy timbers. But even with strings and 3-D joint models as guides, many timber joints needed fine tuning with chisels.*

Figure 2. Prefinished 1x10 tongue-and-groove pine made an attractive finished ceiling. Stress-skin panels sat above the pine.

Figure 3. *On an earlier project, we used sliding doors with fiberglass frames. Even with snow on the ground, they don't fog. The large roof windows operate by remote control.*

Solar Orientation

When we can, we orient a pool building to take advantage of solar gain. We look for glazing systems that balance high solar input with minimum heat loss. We like to use a Heat Mirror 88 in a single-film configuration with two air spaces. In sunrooms and house windows, double glazing might be enough, but with an indoor pool one needs a much higher R-value to reduce the rate of interior condensation during periods of cold weather. A minimum of R-4 glazing is best for condensation control.

We offer as options various "high-tech" glazing systems i.e., low-e, Heat Mirror, and gas-filled units. For Heat Mirror products, we've had very good luck with Alpen, Inc. in Boulder, Colo. Our company also runs through a fair amount of phone time looking for various stock, custom, and DIY window and door systems which will allow for glazing thicknesses that range from a minimum of 1 inch to a maximum of 21/2 inches. The phone time is worth it because of savings we've realized by shopping around, and we are always finding new products to offer our clients.

Opening Roofs

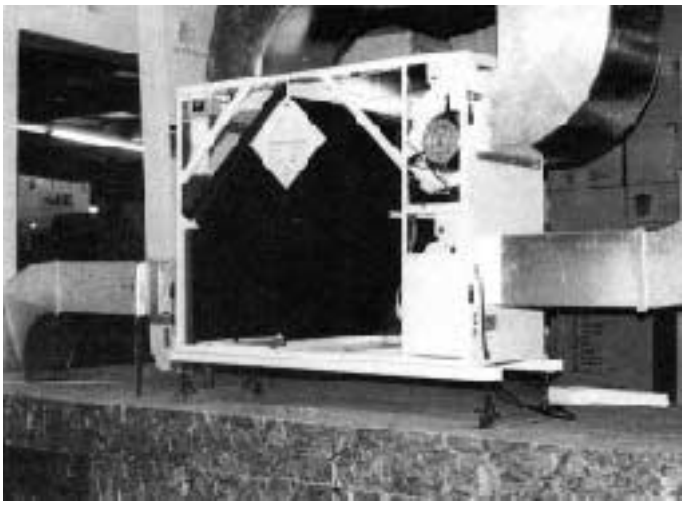
Venting roof windows and opening roofs play an important role in all these jobs. Our two favorites are the opening roof systems offered by Atria, Inc. in Mequon, Wis., and the venting roof windows by Wasco, in Sanford, Maine. The Atria opening roof is essentially a giant (8-foot-wide by up to 30-foot-long) triple-glazed, polycarbonate sliding window placed on the slope so the "top" half slides down over the bottom half. The large roof opening provides great stack ventilation and beautiful views. There's nothing like barbecuing next to the pool.

On the Smith's job, we didn't have quite the solar gain that we would have preferred. The Atria roof system has some thermal bridges through the frame, and the glazing area is very large with a relatively low R-value. So, to get the same condensation protection and tunability in shading coefficient required, we used four venting Wasco roof windows with remote electrical openers. We like Wascos because they use Heat Mirror as their standard glazing; we needed the remotes because the windows were 18 feet high and over the pool. With the electric controls, we were able to set a thermostat to open the windows in the summer to help exhaust the heat.

Windows and Doors

Windows and doors are often one of the trickier parts of a pool job, in part because of the number of options. After much searching, I have found an American-made door produced by Inline International of Maumee, Ohio that works well for pool-construction. This door offers the tightness of the European tilt-turn door and window lines, but not the tilt/turn tricks. Its costs are nearer those of the American sliders, but with an air-infiltration rating that is one fortieth that of the big name brands. I try to use this door whenever a slider is called for or when I want a venting solar wall. I can get it with Heat Mirror; its fiberglass frame comes in white or bronze, and it is paintable (at least in theory). Its sliding action is like that of a van: the active sash slides over and into its closing position; then, if you give it a healthy squeeze, a pivoting handle turns against a cam, locking the sash into the same plane as the fixed panel (see Figure 3). For name-brand windows we often use Marvin, Hurd, and Delite. For this job, though, we decided to make all the windows ourselves from stock window sash material and glazing supplies. This turned out to be cheaper. Also, it offered us more flexibility in design, because we were able to custom-shape and custom-size the windows. We made

Curing Poolside Humidity



Aaron Usher

For heat recovery ventilation, the author likes the vanEE 7000 due to its polypropylene core and high airflow rate.

Vapor rising from pools or spas has been known to attack pool enclosures, leaving structural damage in its wake. With a little planning and investment, most pool room humidity damage can be avoided.

Don't underestimate the enormous quantity of water that pools and spas release into the indoor environment. As many as four gallons can evaporate off the surface of a 500-square-foot pool every hour, boosting the room's relative humidity.

Relative humidity is an index used by mechanical engineers to quantity how "wet" air is. It's important to maintain a minimum relative humidity of 50% so wet swimmers don't feel chilled as they're toweling out their ears at poolside. Should the relative humidity exceed about 60%, the humidity monster begins to rear his ugly head and wreak havoc. On a cold winter night, water will condense on windows, walls, and floors. Uncontrolled moisture can warp wood, rust metal, promote mildew growth, and weaken hidden structural members.

There are some simple strategies you can use right off to minimize pool water evaporation. For instance, you should keep the pool as cool as possible. Temperatures for exercise or lap pools range from 78° to 80°F, and pleasure swimmers prefer the 80° to 84°F range. Conversely, higher air temperatures lower the evaporation rate (due to the higher vapor pressure on the air). Pool-room temperatures typically vary from 78° to 85°F, and ideally should be kept two degrees higher than the water. Ignore the longstanding myth that pool rooms don't need heating systems because losses from the pool keep them warm. If the air temperature is higher than the pool water, this obviously can't be true.

While playing with air and water temperatures will limit evaporation, further measures are required to keep your pool room in the acceptable 50 to 55% relative humidity range. The most effective and least expensive device for abating pool/spa evaporation is the cover. Keeping a cover in place virtually eliminates humidity problems, conserves water, and reduces pool heating costs by about 90%. And there are no batteries that need replacing or moving parts to wear out. However, the cover is not a panacea. Sooner or later someone is going to want to take a swim, and we're going to need some means of dehumidification.

Removing Moisture

There are three dehumidification strategies to choose from: ventilation, heat recovery ventilation, and heat-pump dehumidification with heat recovery.

Ventilation. Ventilation is the classic solution. Humid air is exhausted and replaced with fresh dry air from outside. This strategy would be extremely simple, if we didn't have to warm up the incoming air. For example, in Denver where I design about a half dozen pool-room dehumidification systems every year, the above-mentioned 500-square-foot pool will at times require nearly 1,000 cubic feet per minute (cfm) of ventilation. When it's 0°F outside, heating that air to 80°F can eat up 72,000 Btus an hour. The homeowner in this example could spend over $1,000 a year just heating up ventilation air for his pool room.

Heat-recovery ventilation. Heat recovery ventilators, also known as air-to-air exchangers, reduce the energy cost associated with ventilation. They contain plastic or aluminum cores with separate channels for outgoing and incoming air, and a pair of fans to drive the ventilation process. As cold outdoor air is drawn through the exchanger core, it is warmed by the outgoing pool room air. Most heat-recovery ventilators reduce the amount of energy needed to heat up outdoor air by about 65%. A boiler or furnace makes up the rest. This allows you to take advantage of gas or oil-fired equipment.

My favorite heat-recovery ventilator for pool rooms is manufactured by Conservation Energy Systems of Saskatoon, Canada. Their model van EE 7000 contains a polypropylene exchange core with 450 square feet of heat transfer area. Two 3-amp fans move as much as 700 cfm. Most of my clients opt for this strategy.

When installing a heat-recovery ventilator, pay attention to balancing and frosting. If incoming and outgoing airflows are not carefully balanced, the pool room could become pressurized and force humidity and chlorine odors into the main living space. As pool-room exhaust air is cooled down in the exchanger core, water condenses out. In cold climates, this water tends to freeze up and block the exchanger core. Be sure to order a ventilator with a defrost option from the manufacturer.

Heat-pump dehumidification. As good as heat-recovery ventilators are, there's a system I like better. Heat-pump dehumidification systems with heat recovery offer a degree of elegance rarely seen in mechanical systems. They work on the same refrigeration cycle as air conditioners and refrigerators. A fan draws vapor-laden pool-room air across a cold evaporator coil. As the air cools, moisture condenses on the coil and is dumped down the drain or returned to the pool. Energy removed from the air and water vapor is used to warm the air back up to its original temperature and to help heat the pool. A closed system is set up where energy lost from the pool in the evaporation process is ultimately returned. No makeup air needs to be reheated.

At the heart of a heat pump dehumidifier is a compressor, just like the compressor in an air conditioner. Like all mechanical equipment, these compressors are not 100% efficient. However, the heat-pump dehumidifier can use excess energy from the compressor to heat the pool room in winter. Optional exchangers are available for heating water for showers, and remote condensers are available for cooling.

What's the catch? These systems have a high up-front cost. A system for a residential pool can cost up to $15,000. Also a fair amount of money is spent on electricity to run the compressor. Depending on the cost of electricity, the heat pump systems still pay for themselves in six or seven years (compared to exhausting the air and reheating it with electric resistance).

Handling Warm, Dry Air

Regardless of which dehumidification strategy is used, there are factors common to all. Warm dry air must be blown on all glass surfaces continually during cold weather. It is almost impossible to dry the air enough by ordinary means to keep condensation from occurring. By directing warm dry air at all windows, patio doors, and skylights, condensation can be reduced. The defroster in your car works on the same principle.

The most attractive pool dehumidification systems expel air from aluminum linear floor diffusers. Air is supplied to the diffusers by vinyl-coated ducts hidden under the pool deck. A less expensive system—one that can be retrofitted—employs overhead duct and stamped-steel ceiling diffusers. Where ductwork is exposed, use spiral paintock steel duct with a water-resistant paint.

Adjustable return air and exhaust grilles should be located either low or high on the wall. They should be made of aluminum. Return and exhaust ductwork should be fabricated from aluminum, plastic, or other water-resistant materials.

If you discover excess humidity in a pool room, you can do something about it. Remember these three simple steps:

- Cover the pool when it's not being used.
- Keep the air temperature high and the pool cool.
- Install a dehumidification system that directs air at all glass surfaces.

Now blow up the beach ball and pour some drinks. We're going to celebrate the vanquishing of the humidity monster with a cool pool party.

For More Information

For further information, contact:

- Conservation Energy Systems, Inc., 3310 Millar Ave., Saskatoon, Sask., Canada S7K 7G9
- Advanced Refrigeration Products, Inc., 366 Hollow Hill Drive, Wauconda, IL 60084.

Jay Stein designs mechanical systems for custom homes in Denver, Colo.

Figure 4. *About the size of a drinking fountain, EDI's Ventaire unit combines heat distribution with heat-recovery ventilation.*

a white fiberglass-clad exterior (you can find pre-clad stock) with a wood interior, and we got fixed panes of 11/4-inch-thick Heat Mirror glazing in custom dimensions. We did the same for the fixed skylights except that they got quad-glazing from Alpen with two Heat Mirror films, topping out at 21/2-inches thick. Moisture is not likely to ever condense on these.

Heating and Hvac

In designing the heating system, our heating designer Drew Gillett, of Bedford, N.H. had to address the issue of indoor air quality in this tightly built space with a high moisture source. Gillett specced Engineering Development, Inc.'s, of Colorado Springs, Colo., (EDI) Ventaireheat-recovery ventilator to handle the heating and ventilation of the area. The system which combines an air-to-air heat exchanger with a fan-coil heating unit is powered by hot water from the owner's existing boiler (see Figure 4). This lets them take advantage of the low costs of oil heating (see "Curing Poolside Humidity").

In many cases, our clients' existing heating systems are sufficiently oversized that they can supply the new pool room. When the systems are run more continually to meet the bigger load, they perform at higher efficiency. We sometimes also boost performance by adding air intakes, or thermal storage.

All lighting in the building is provided by high-efficiency compact fluorescents to keep lighting costs down by 80%. The pool pumping and filtration system is powered by a photovoltaic (pv) array that was installed by Sunnyside Solar of Brattleboro, Vt. This approach works well in that demand for filtration often corresponds to sunny days when pv outlet is highest.

When feasible, radiant floor heating is an effective way to heat an indoor pool building. The heat is very even, it dries water spills fast, it warms the feet, and it allows the air temps to be slightly lower than normal (warm feet, cool head). However, with heavy pool use during very cold weather, higher indoor air temperatures may be needed to reduce condensation, requiring an air circulation heating and venting system.

By placing our emphasis on panelized construction, we hope to decrease the time it takes to erect large additions and homes. Our emphasis on renewable energy is shared by the clients who seek us out. Even with this larger aim, we still want the immediate gratification that every builder wants at the end of the day—to stand back and feel the pride of participation in good-looking work.

Our clients' existing heating systems are often sufficiently oversized and they can supply the new pool room. When the systems are run to meet the bigger load, they often perform at higher efficiency.

For Further Information

- Engineering Development, Inc. (EDI), Ventaire-Heat, Recovery Ventilators, c/o Joseph Migliore, Progressive Building Systems, 23 Jane St., Closter, NJ 07624, on the east coast, and elsewhere 4850 No. Park Dr., Colorado Springs, CO 90807, 800/777-8368.
- Annemarie Mitchell, Legacy Timber Frames, RD 1, Box 60, troy, NY 12180.
- Remarc., RFD 3, Box 93C, Plymouth, NH 03264.
- Sunnyside Solar, RD 4, Box 808, Green River Road, West Brattleboro, VT 05301.
- Teknikote, 396 Roosevelt Ave., Pawtucket, R 02863. ■

Doug Immel owns Daylight Incorporated, in Woonsocket, R.I.