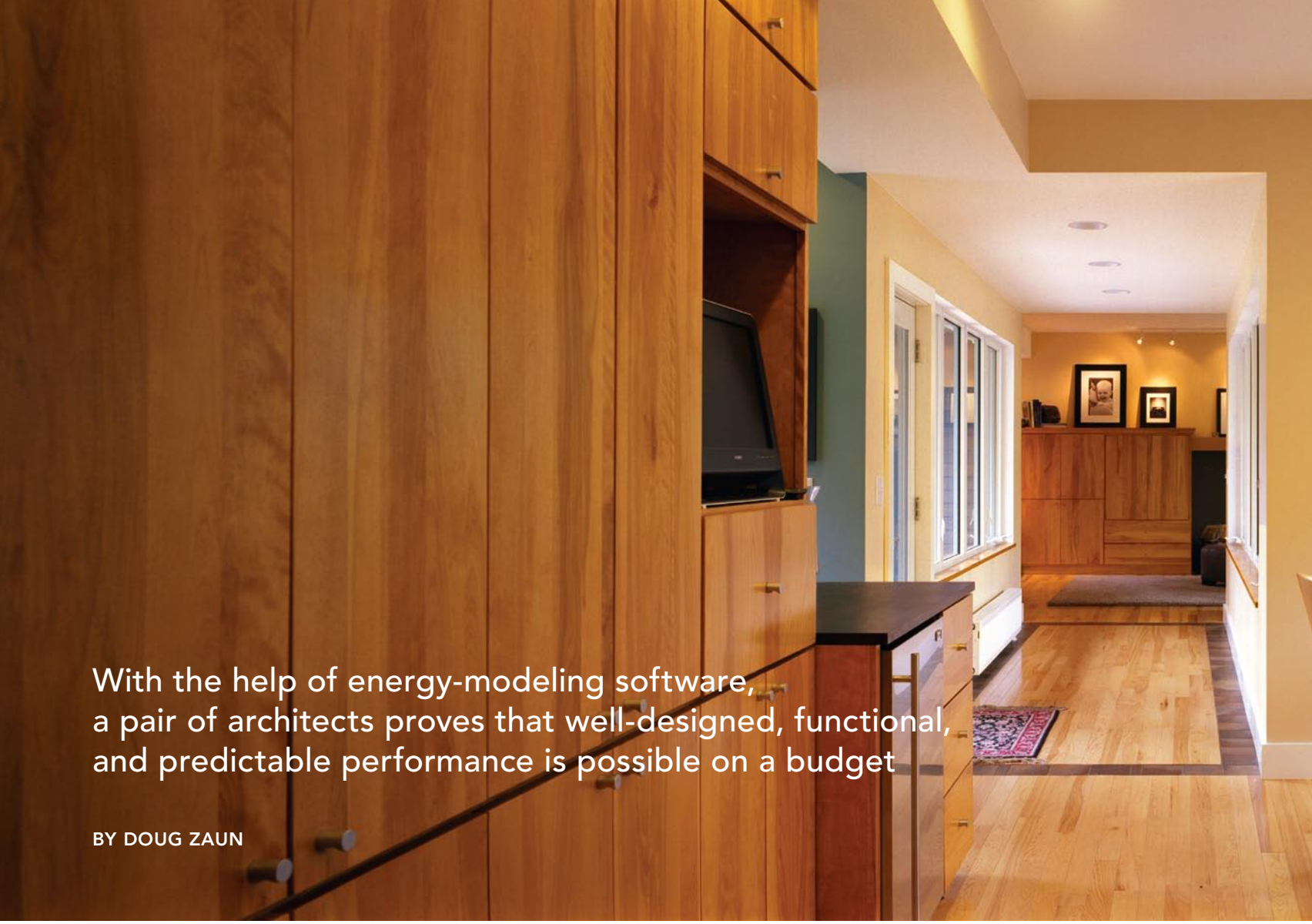


With the help of energy-modeling software, a pair of architects proves that well-designed, functional, and predictable performance is possible on a budget

BY DOUG ZAUN

Getting to Cozy and

Here in Duluth, Minn., the summers are stunning and mild, and the winters literally can take your breath away. While 5° below zero is routine, 20° below is common. Designing energy-efficient homes for this extreme climate is challenging, but for our firm, energy-modeling software is taking some of the guesswork out of the process (sidebar p. 80).

Ryan and Shari came to us with a mostly steep, heavily wooded lot in a small development on a ridge adjacent to the headwaters of Chester Creek. The lot includes a level portion at the top of the hill, and then two-thirds of the property drops steeply south toward the creek. The couple wanted a home that took advantage of the broad southern exposure as well as the land's natural features.

A home already had been constructed to the west, and we knew at some point that another home would be built to the east. The natural location for our cli-

Photo above: Peter Bastianelli-Kerze

Efficient in Duluth

ents' house was just past the level hilltop. This would site the home far enough into the lot to create privacy and would take advantage of the level portion for the garage and driveway. The location also created an opportunity for a walkout basement to access the lower part of the site.

Simple shapes save money

Ryan and Shari wanted a house that was both large enough for an active young family and energy efficient enough to keep their heating costs to a minimum. We had to stay within a modest budget, and the house had to have a south-facing covered porch.

We know that simple forms are economical to build because there's less waste and they require less labor. We also know that simple forms are more energy efficient. We followed this less-is-more approach as we located the spaces. Bedrooms would be on the upper level; living space on the main level; and mechanical, storage, and future expansion spaces on the basement level. Protected outdoor space would be accessed from the main living areas.

Porch takes center stage

Our early designs showed a simple rectangular floor plan with bedrooms over the living area: functional and practical. But grafting a covered porch onto the south side of the main level would steal the daylight. Then we thought, "Why not pull part of the outdoor space

Looks separate but feels connected. *The kitchen and dining areas are accessible from the living room via the foyer. Sliding-glass doors provide access to the porch from the dining and living areas and allow more natural light to the main floor. The doors make each space readily visible to each other, while a hallway keeps them connected. Photo taken at A on floor plan; photo facing page taken at B.*

ENERGY-MODELING SOFTWARE

Predict the cost and performance of energy-saving upgrades

by Rachel Wagner

For us, the question isn't whether to make a home energy efficient—it's how energy efficient to make it. In our climate, we focus most on heating because that's responsible for more than half of the energy consumed in the average Minnesota home. We begin the process by assessing the project goals and budget with the client, then set a target for efficiency. Next, we turn to REMDesign (www.archenergy.com) energy-modeling software to figure out how we'll achieve that target within the project's budget. Here, the target was to perform 50% better than code.

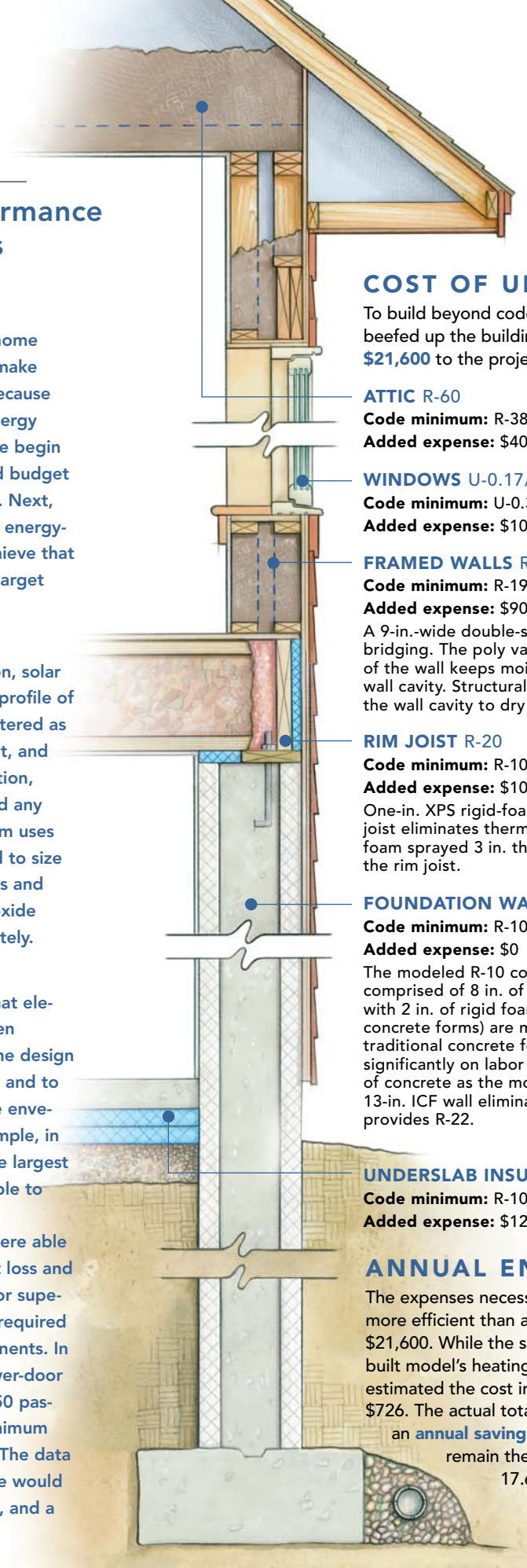
Input data, get thorough reports

REMDesign software uses data such as location, solar orientation, floor area, and volume to build a profile of the house. Specific building assemblies are entered as well as information about the fuels, equipment, and efficiencies for space heating, cooling, ventilation, domestic hot water, lighting, refrigeration, and any active solar technologies planned. The program uses this data to generate reports that can be used to size the heating system and to review energy loads and consumption, estimated costs, and carbon-dioxide emissions, all considered as a whole or separately.

Analysis yields sound decisions

The opportunity to analyze choices tells us what elements are having the biggest impact on a given design. The information allows us to modify the design (for instance, changing the amount of glazing) and to guide the decisions in the development of the envelope assemblies and insulation levels. For example, in this design, the framed walls accounted for the largest heat loss. With the builder's input, we were able to choose the most cost-effective approach.

By building a code-built house model, we were able to look at the components with the most heat loss and immediately upgrade a number of elements for superior performance. The most sizable upgrades required increasing insulation values for various components. In addition to these upgrades, we sought a blower-door test rating of 1 air change per hour (ACH) at 50 pascals. (Although there isn't a code-required minimum for airtightness, we use 5 ACH in our model). The data provided an accurate picture of how the house would perform, the added cost for various upgrades, and a realistic estimate of annual savings.



COST OF UPGRADES

To build beyond code minimums, the authors beefed up the building envelope, which **added $21,600** to the project (breakdown below).

ATTIC R-60
Code minimum: R-38
Added expense: $400

WINDOWS U-0.17/0.19, south side
Code minimum: U-0.35
Added expense: $10,000

FRAMED WALLS R-34
Code minimum: R-19
Added expense: $9000
A 9-in.-wide double-stud 2x4 wall eliminates thermal bridging. The poly vapor barrier on the warm side of the wall keeps moist interior air from entering the wall cavity. Structural fiberboard sheathing allows the wall cavity to dry to the outside.

RIM JOIST R-20
Code minimum: R-10
Added expense: $1000
One-in. XPS rigid-foam insulation at the rim joist eliminates thermal bridging. Polyurethane foam sprayed 3 in. thick insulates and air-seals the rim joist.

FOUNDATION WALLS R-22
Code minimum: R-10
Added expense: $0
The modeled R-10 code-built foundation wall was comprised of 8 in. of poured concrete covered with 2 in. of rigid foam. Although ICFs (insulated concrete forms) are more expensive than traditional concrete forms, the as-built wall saved significantly on labor and used the same amount of concrete as the modeled wall would have. This 13-in. ICF wall eliminates thermal bridging and provides R-22.

UNDERSLAB INSULATION R-20
Code minimum: R-10
Added expense: $1200

ANNUAL ENERGY SAVINGS

The expenses necessary to make this home 50% more efficient than a code-built house totaled $21,600. While the software projected the code-built model's heating to run $1844 annually, it estimated the cost in the as-built model to be only $726. The actual total in 2008 was $616. Given an **annual savings of $1228**, if energy prices remain the same, the upgrades will take 17.6 years to pay off.

Drawing this page: Bob La Pointe. Floor-plan drawings, facing page: Martha Garstang Hill.

into the house?" In doing so, the porch became a little courtyard, and a simple floor plan became interesting. The main living areas were no longer shaded by the porch. Better yet, the recessed porch actually allowed more natural light into these spaces. Dining and kitchen areas would receive morning light earlier, and the living room would capture afternoon light later.

The living room and dining-kitchen area were separated from each other by the porch but connected to the porch itself via large sliding doors. A hallway between the spaces, which runs alongside the porch, became a large picture window to the north, creating a welcoming, clear entrance. Main-floor living was now both private and connected.

Efficiency and budget were the next challenge

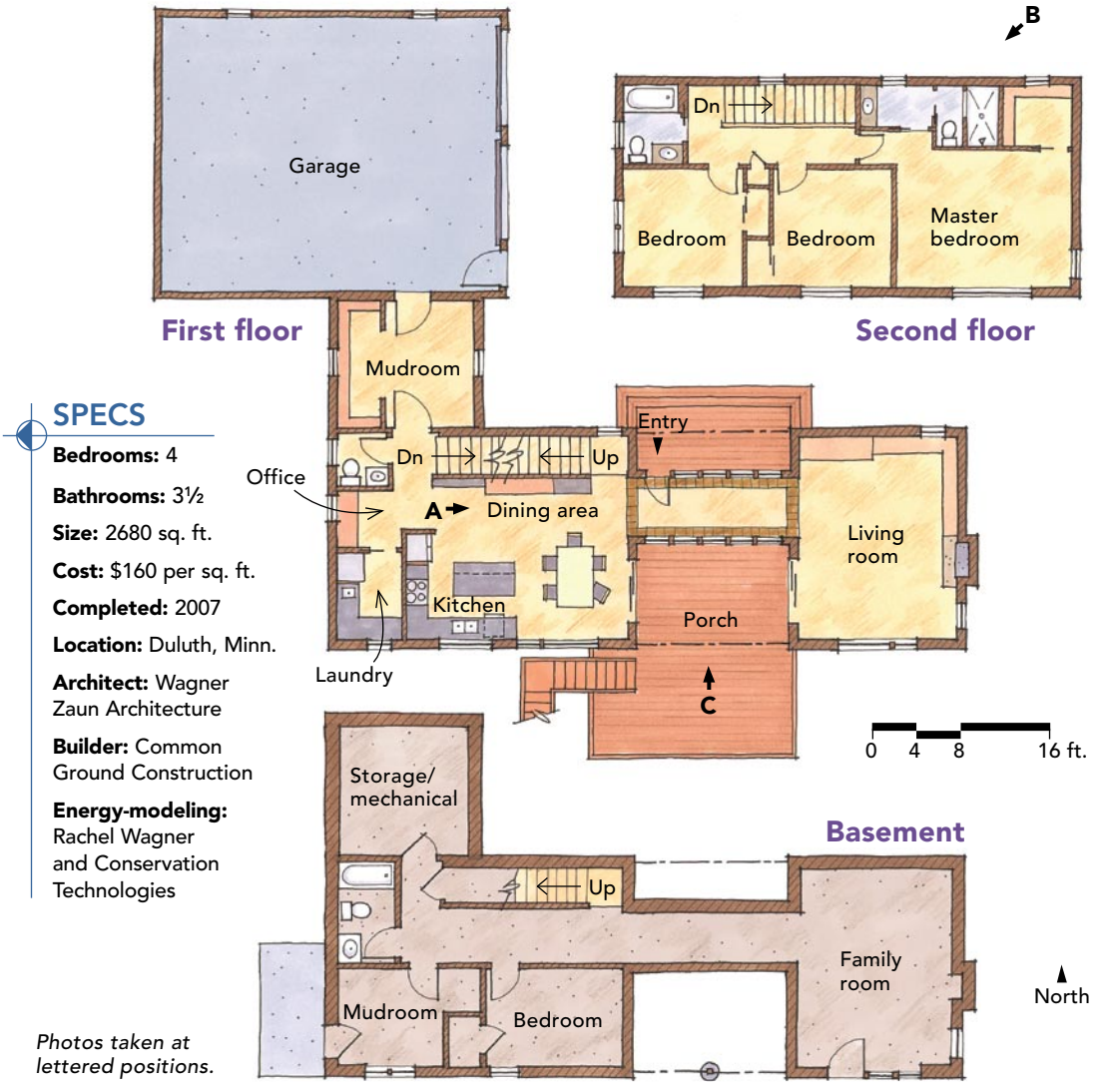
Our goal was to reduce the house's energy usage by 50% when measured against the energy code's minimum standards. To that end, we used modeling software to evaluate the performance of various parts of the house and to make upgrades accordingly. We computed that for an investment of 6% now, the homeowners could expect to save 60% on energy bills every year for the life of the home. This was an investment that Ryan and Shari were willing to make.

To make some of the upgrades, we needed to save money in other areas. Ryan and Shari agreed to provide labor and some materials. Ryan installed flooring and all the interior trim. His father fabricated the metal railings at the exterior deck and the interior stair. □

Doug Zaun and Rachel Wagner are partners in Wagner Zaun Architecture in Duluth, Minn. Photos by Ryan Marshik, except where noted.

A PORCH PUTS EVERYTHING IN ITS PLACE

The natural positioning for the covered porch would have obscured solar gain, natural light, and views from the main living areas. Recessing the porch into the south-facing wall provided the desired southern exposure while allowing more natural light into those spaces. A hallway connects the living room and dining-kitchen area while providing views to the north via the front entry. The steep slope allowed for a walkout basement, creating more living space and storage. Photo taken at C.



SPECS

Bedrooms: 4

Bathrooms: 3½

Size: 2680 sq. ft.

Cost: $160 per sq. ft.

Completed: 2007

Location: Duluth, Minn.

Architect: Wagner Zaun Architecture

Builder: Common Ground Construction

Energy-modeling: Rachel Wagner and Conservation Technologies

Photos taken at lettered positions.