Back in the ’70s, as a young engineering student studying energy efficiency, I wondered, “When the price of oil doubles, will the walls we’re building now look smart or dumb?” The answer was obvious: They’ll look dumb. That’s when I started my quest for the future of walls.

Contrary to Hollywood’s advice in The Graduate, the future is not plastics. The present is plastics. The future is wood (actually, it’s cellulose, the stuff wood’s made of), and the future is now. That’s good news for the United States because we’re the Saudi Arabia of cellulose. Saudi Arabia has sand and oil; we’ve got dirt and cellulose. Oil is nonrenewable, but cellulose grows on trees.

The future lies in better wood products and better use of those wood products. OSB, engineered beams, and I-joists are already common products; in the future, we’re going to get a lot more of these types of products. To use all this “engineered cellulose” simply and elegantly, we need to convince hundreds of thousands of builders that the way they’re building now no longer makes sense. Welcome to my world.

Smarter walls are being built today As part of the U.S. Department of Energy’s Building America program (www.buildingamerica.gov), our team focuses on the future of housing. Our target is an affordable and sustainable future. The nearly finished product (center house) looks normal, but its energy performance is superior.

Smarter framing means less wood Extraneous studs, headers, and plywood don’t boost structural integrity as much as they sabotage energy performance. For 30 years, engineers have been trying to convince us that the way we frame houses is inefficient; there’s too much redundancy even for them. But with houses and energy costing more than ever, it’s time to listen. This Colorado subdivision illustrates that some builders not only are listening but also are using smarter framing strategies. The minimalist skeleton, which makes room for more insulation, is visible in the house in the foreground and in the photo below. The insulating skin, visible on the house in the background, boosts the R-value. The nearly finished product (center house) looks normal, but its energy performance is superior.

Unfortunately, missing headers, minimal framing, and foam sheathing just look like a flimsy house to many skeptical builders who will look at these photos and say …

Yeah, but…

A What about shear strength?

Sometimes sheathing with 1-in. foam, shear strength can come from strategically placed 1⁄2-in. OSB covered with 1⁄2-in. foam or from site-built shear panels (see p. 55).

A What about bouncy floors?

Yes, removing every third joist could make the floors more bouncy, but using thicker subfloor (11⁄8-in. panels) will stiffen it back up.

A What about blocking for drywall?

Using drywall clips and floating the corners (leaving them unattached to the framing) are excellent ways to reduce drywall cracks.

A What about flimsy walls?

Half-inch drywall over studs 24 in. on center isn’t all that flimsy (especially over dense-pack cellulose), but if you don’t believe it, then use 5⁄8-in. drywall.
How can smart framing affect R-value?

A Wood is not a good insulator.

More often than not, the R-value of walls is assumed to be the same as the insulation in them. But this assumption doesn’t consider all the wood framing connecting interior and exterior surfaces. Thermal bridging across framing members reduces overall R-value because a 2x4 or 2x6 is a poor insulator compared to fiberglass or cellulose. That’s why eliminating unnecessary lumber (even if you can use the handy calculator at the Oak Ridge National Labs Web site: www.oml.gov/sci/roofs+walls/AWT/InteractiveCalculators/rvalueinfo.htm).

How can smart framing save money?

A Fewer pieces go together faster, make less work for everyone, and leave more room for insulation.

A case study of two identical 2000-sq.-ft. houses designed for a Centex Homes sub-division in Minnesota illustrate the magnitude of savings a single house can achieve. A comparison of wall elevations shows why one is cheaper to build, cheaper to heat and cool, and more polite toward environmental issues (such as greenhouse-gas emissions, resource conservation, and landfill congestion). Similar cost and resource efficiency also has been demonstrated on building sites in hot and mixed climates.

**Table 1: Cost of wall framing and amount of wall that can be insulated**

<table>
<thead>
<tr>
<th>Design type</th>
<th>Materials in 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, entire house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>75%</td>
<td>$710</td>
<td>68%</td>
<td>$4,039</td>
</tr>
<tr>
<td>Standard wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>68%</td>
<td>$600</td>
<td>57%</td>
<td>$3,300</td>
</tr>
</tbody>
</table>

More often than not, the R-value of walls is assumed to be the same as the insulation in them. But this assumption doesn’t consider all the wood framing connecting interior and exterior surfaces. Thermal bridging across framing members reduces overall R-value because a 2x4 or 2x6 is a poor insulator compared to fiberglass or cellulose. That’s why eliminating unnecessary lumber is likely.

Because it’s a bath of air, this a frigid wall. Cold spots condense moisture and can create a breeding ground for mold.

Wood is a thermal bridge

Three stud corners limit heat transfer. The wooden bridge and air pockets shuttle cold air through the wall. Cold spots condense moisture and can create a breeding ground for mold.

**Table 2: Comparison of wall framing and amount of wall that can be insulated**

<table>
<thead>
<tr>
<th>Design type</th>
<th>Materials in 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, entire house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>75%</td>
<td>$710</td>
<td>68%</td>
<td>$4,039</td>
</tr>
<tr>
<td>Standard wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>68%</td>
<td>$600</td>
<td>57%</td>
<td>$3,300</td>
</tr>
</tbody>
</table>

More often than not, the R-value of walls is assumed to be the same as the insulation in them. But this assumption doesn’t consider all the wood framing connecting interior and exterior surfaces. Thermal bridging across framing members reduces overall R-value because a 2x4 or 2x6 is a poor insulator compared to fiberglass or cellulose. That’s why eliminating unnecessary lumber is likely.

Because it’s a bath of air, this a frigid wall. Cold spots condense moisture and can create a breeding ground for mold.

Wood is a thermal bridge

Three stud corners limit heat transfer. The wooden bridge and air pockets shuttle cold air through the wall. Cold spots condense moisture and can create a breeding ground for mold.

**Table 2: Comparison of wall framing and amount of wall that can be insulated**

<table>
<thead>
<tr>
<th>Design type</th>
<th>Materials in 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, entire house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>75%</td>
<td>$710</td>
<td>68%</td>
<td>$4,039</td>
</tr>
<tr>
<td>Standard wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>68%</td>
<td>$600</td>
<td>57%</td>
<td>$3,300</td>
</tr>
</tbody>
</table>

More often than not, the R-value of walls is assumed to be the same as the insulation in them. But this assumption doesn’t consider all the wood framing connecting interior and exterior surfaces. Thermal bridging across framing members reduces overall R-value because a 2x4 or 2x6 is a poor insulator compared to fiberglass or cellulose. That’s why eliminating unnecessary lumber is likely.

Because it’s a bath of air, this a frigid wall. Cold spots condense moisture and can create a breeding ground for mold.

Wood is a thermal bridge

Three stud corners limit heat transfer. The wooden bridge and air pockets shuttle cold air through the wall. Cold spots condense moisture and can create a breeding ground for mold.

**Table 2: Comparison of wall framing and amount of wall that can be insulated**

<table>
<thead>
<tr>
<th>Design type</th>
<th>Materials in 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, entire house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>75%</td>
<td>$710</td>
<td>68%</td>
<td>$4,039</td>
</tr>
<tr>
<td>Standard wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>68%</td>
<td>$600</td>
<td>57%</td>
<td>$3,300</td>
</tr>
</tbody>
</table>

More often than not, the R-value of walls is assumed to be the same as the insulation in them. But this assumption doesn’t consider all the wood framing connecting interior and exterior surfaces. Thermal bridging across framing members reduces overall R-value because a 2x4 or 2x6 is a poor insulator compared to fiberglass or cellulose. That’s why eliminating unnecessary lumber is likely.

Because it’s a bath of air, this a frigid wall. Cold spots condense moisture and can create a breeding ground for mold.

Wood is a thermal bridge

Three stud corners limit heat transfer. The wooden bridge and air pockets shuttle cold air through the wall. Cold spots condense moisture and can create a breeding ground for mold.

**Table 2: Comparison of wall framing and amount of wall that can be insulated**

<table>
<thead>
<tr>
<th>Design type</th>
<th>Materials in 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, 40-ft. wall</th>
<th>Amount of wall that can be insulated</th>
<th>Cost of wall framing, entire house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>75%</td>
<td>$710</td>
<td>68%</td>
<td>$4,039</td>
</tr>
<tr>
<td>Standard wall framing</td>
<td>Materials: 24 stud-wall, 21 insulation panels, 28 insulation pieces</td>
<td>68%</td>
<td>$600</td>
<td>57%</td>
<td>$3,300</td>
</tr>
</tbody>
</table>

More often than not, the R-value of walls is assumed to be the same as the insulation in them. But this assumption doesn’t consider all the wood framing connecting interior and exterior surfaces. Thermal bridging across framing members reduces overall R-value because a 2x4 or 2x6 is a poor insulator compared to fiberglass or cellulose. That’s why eliminating unnecessary lumber is likely.

Because it’s a bath of air, this a frigid wall. Cold spots condense moisture and can create a breeding ground for mold.

Wood is a thermal bridge

Three stud corners limit heat transfer. The wooden bridge and air pockets shuttle cold air through the wall. Cold spots condense moisture and can create a breeding ground for mold.
I’m still skeptical. Do I have to adopt all of these strategies? They all make sense, but some give more bang for the buck.

You don’t have to use all these details, but a couple of them will save you a bundle. Rather than switching all at once, start with the most efficient upgrades, then phase in new details after each is incorporated into your standard operating procedure. Cost savings are based on a $200,000, 4,000 sq ft house (see case study on previous page).

PHASE 1
Design in 2-ft. modules
The best thing you can do is to switch from 2x4 studs at 16-in. spacing to 2x6 studs at 24-in. spacing. Stack the floor, wall, and roof framing, and place windows and doors on the stud layout. Next, replace plywood or OSB wall sheathing and housewrap with at least 1 in. of rigid foam sheathing. These steps will save you significant money and labor, and they’ll boost R-value by 50%. And walls framed on the deck will be much lighter and easier to stand up. Cost saving: $500.

PHASE 2
Eliminate cold spots
Structural headers aren’t needed in non-load-bearing situations; size them properly in bearing situations. Corners and wall blocks make more cold pockets in a standard-frame wall. Use two-stud corners, and eliminate blocks to keep insulation consistent. Drywall can be floated at the corners (which reduces cracks anyway) or fastened with drywall clips. Cost saving: $135.

PHASE 3
Fine-tune the savings
Use header nailing rather than jack studs at door and window openings. If cripples under windows are less than 24 in. tall, eliminate them altogether. This saves labor and materials, but may make trim installation more difficult. Eliminating one of the top plates is a final material-saving upgrade, although until precast studs are available at 94 in., this may complicate drywall installation. Cost saving: $120.

“...We’re the Saudi Arabia of cellulose. Oil is renewable, but cellulose grows on trees.”

Because we can make sheathing, beams, joists, and rafters with small trees that are chopped up, we really don’t need to drive old-growth forests in the mountains to get the wood we need. We can grow trees on the land, such as Ohio and Indiana. But cellulose also can be extracted from fast-growing plants rather than from trees, so maybe that’s what we should plant in Ohio.

What about seismic and hurricane areas?
Build a shear panel to slip between the studs.

Insulating sheathing is an attractive alternative to OSB, but a major drawback is the lack of shear strength in a foam panel. One way to gain shear strength is to install 1⁄2-in. plywood or OSB at critical locations of a house, and then skin over it with 1⁄2-in. foam sheathing. A better solution is a shear panel that fits into the wall framing, leaving the exterior foam intact. Leave one stud out and insert the 46⁄8-in. panel. Built with readily available building materials for around $100, the panel is secured into the wall with nails and framing connector plates and bolted continuously from the top plate to the foundation anchor bolts. This panel (developed by Building Science Corp. and the Army Corps of Engineers) is engineered for site-built applications, but an engineer should specify where and how many to use.

What does the future hold?
In the future, building materials will work a lot harder. Foam sheathing will pass water vapor selectively if a wall gets wet. Housewraps will change characteristics depending on orientation, season, and climate. Ballistic housewraps will protect houses from projectiles in seismic and hurricane areas.

But smarter materials can’t achieve their potential without smart building. Why aren’t more houses built smarter? Because it’s different. What we have is an inefficient framing system that we are all doing incredibly efficiently. We need to refocus on a more efficient system. The transition can be in phases to reduce the learning curve, but it will take about 10 houses for a framing crew to execute smoothly. If you want to change, you will, but with the current building boom, everything sells so quickly that there’s no incentive to slow down your system. When the boom fades, change will take place. Of course, at $65 a barrel, who cares, too.