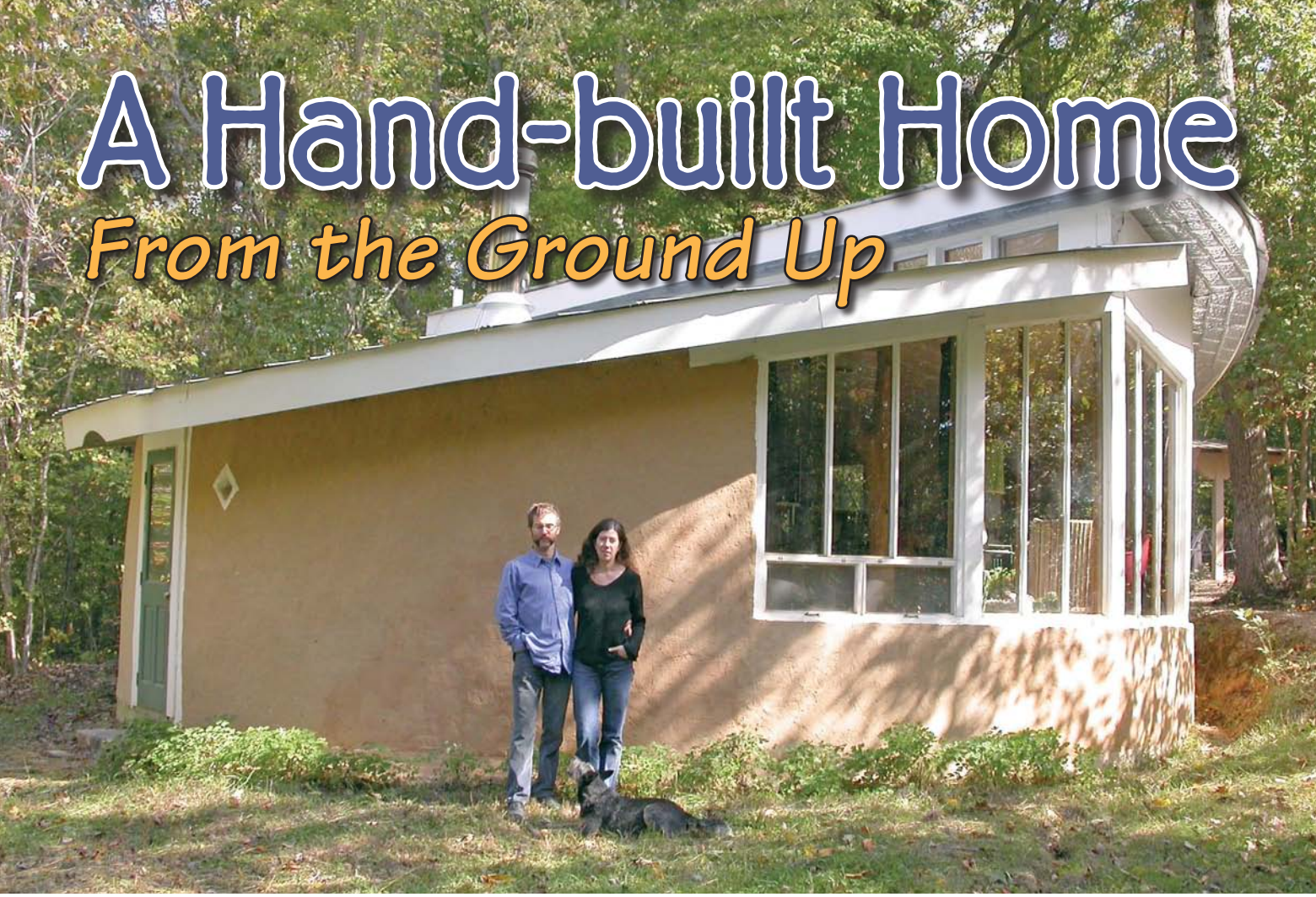
A Hand-built Home
From the Ground Up



The author and his wife in front of their hand-built cob house in North Carolina.

Stephen Hren

When my wife Rebekah and I decided to build our own house, we began researching various alternative building techniques that would be appropriate for our climate and resources here in the Piedmont region of North Carolina, about 30 miles (48 km) north of Durham.

We briefly flirted with the idea of building a monolithic concrete dome, even going so far as to have a round, 800-square-foot (74 m^2) concrete slab poured. But our flirtation ended when we actually saw a dome home—it looked like a UFO had landed in the woods.

Now we had a large slab and a really big pile of clay from the excavation. We investigated other natural building methods, but after eyeing the mound of earth in our yard, we decided to build our house out of cob—a mixture of clay, sand, and straw (also called monolithic adobe).

Our completed cob house fits perfectly on the round slab, and blends beautifully with our surrounding landscape, having risen directly from it. The materials that weren't free were inexpensive (see the costs table), and we were able to build it ourselves—with a lot of help from our friends, of course. This energy efficient home also has a 310-watt PV system, which meets all of our electricity needs, including water pumping and refrigeration. We run as much as we can on DC power (including LEDs and fluorescent bulbs), which also is more efficient.

From the Ground Up

Cob is a very versatile and stable material, so the options for a home's design are numerous. Although our round cob house's curved walls have their advantages, they have one major drawback. With curved walls, integrating the roof, floors, and windows gets quite tricky, and using milled lumber results in lots of scraps. The construction could frustrate some carpenters—and if you're hiring the work out, could result in a poor job or add to the total cost. However, the advantages are many.

First of all, walls with substantial curves in them are self-bracing—they inherently distribute building stresses more evenly than rectangular structures. This can make a well-designed circular cob building very strong.

This gently sloped roof puts less weight on the cob walls while simultaneously providing enough of an angle to shed snow.

Round walls also help direct the wind flow *around* the house. This lessens the stress on the house during extreme weather. But keep in mind that a given building's design and engineering will ultimately determine how structurally sound it is.

While cob has tremendous compressive strength (it can hold up much more than it weighs), cob walls can fail due to vertical pressure or loading from the roof, especially in areas that experience heavy snowfall. For our project, we considered two design elements. First, steeper roof systems are somewhat heavier than low-pitched ones, but shed snow better. If you live where you receive heavy snowfalls like we do, your building design needs to take into account both roof structure and snow loading on the cob walls. Second, because we wanted a lower pitched roof, additional support in the center of the house was necessary to transfer a portion of the roof's load directly to the ground rather than outward on the walls.

Bulk Up & Add Mass

Plan to incorporate some kind of exterior insulation into your cob home. Near the end of our inspection process, our inspector questioned the insulation value of our 12- to 16-inch-thick (30–40 cm) cob walls. I had been sure they would be adequate, so I was shocked when I discovered their total R-value to be only R-3 or R-4 (about R-0.25 per inch). This was unacceptable, so we had to find a way to insulate the outside of our cob home if we wanted to get our final certificate of occupancy. To help boost the R-value of our home, we ended up painting the outside with a new-fangled coating called Nansulate, which uses itty-bitty ceramic tubes that effectively trap air to slow heat transfer.

Neither my wife nor I were thrilled with the idea of painting the gorgeous exterior of our home, but the practical results were eye-opening. The combination of our high thermal mass walls now surrounded with insulation remarkably improved the energy efficiency of our home.

Houses, due to their relative longevity compared to other fuel consumers, such as cars or household appliances, will be the last to adapt to the greater scarcity of fossil fuels. So considering energy use in designing and building new homes is of paramount importance. With fossil fuel availability likely on the edge of permanent decline, anything that reduces energy use in the day-to-day operation of a home is a good thing.

My wife and I are in the process of removing the insulation coating (although it stuck to the walls just fine) and are going to experiment with natural types of insulation, such as vermiculite or perlite mixed into cob. These natural insulations have the advantage of being much more permanent, while allowing the home's earthen walls to breathe better.

Additional support in the center of the house was necessary to transfer a portion of the roof's load directly to the ground rather than to the walls.

Insulation Ideas

Vermiculite or perlite mixed into the cob. Vermiculite and perlite have an insulation value of about R-2 to R-4 per inch; a 4- or 6-inch-thick (10–15 cm) application would be needed.

The author places the first rafters in the cob walls, after "keying" them to lock them into place.

Hybrid straw bale and cob. The cob provides the structure and thermal mass, while the straw provides the insulation.

A wattle-and-daub frame built around the exterior. This could be as simple as a 2-by-6-inch frame stuffed with straw. Wire mesh or some other lath (such as bamboo or strips of oak) is applied to the outside and is plastered as desired. The straw should be dipped in a clay slip (clay mixed with water) and allowed to dry to help improve its resistance to fire.

Besides insulation, another important design element incorporates interior cob walls, which add thermal mass to the structure. Alternatively, you may want to add an interior cob wall to an existing structure, or to a straw bale (or other well-insulated) house to help regulate interior temperatures. Since cob also is excellent for reducing noise, consider separating the sleeping quarters from the rest of the house with such a wall.

Cob Construction Tips

Cob loads must be distributed over door and window openings using either lintels or arches. Wood and stone lintels are common; they should extend at least 6 inches (15 cm) into the cob on either side of the opening. Use rot-resistant woods, such as oak or cedar, and treat with a natural preservative, like linseed oil.

Any wood that is incorporated into your cob structure for door and window framing should be keyed to help lock it in place. "Keying" refers to additional blocks of wood attached to the framing that give the cob something to "grab." This is especially important for rafters, because the ample roof overhangs (18–24 inches; 46–61 cm) needed to protect your cob walls are susceptible to uplift from strong wind gusts.

Try Your Hand at Cob

To get a feel for this material, start with a small project, such as a bread oven or greenhouse. You'll need a source of clay, sand, and straw. Often, clay and sand can be recovered from different layers of soil. Here in North Carolina, we have a subsoil of red clay, and sand can be found along stream banks. It's important to minimize the amount of organic matter in the mix; it can decay, leaving holes in the structure. If you need to purchase sand, masonry sand adheres best to clay.

For small projects, you can make cob by foot. On a tarp, add equal quantities of clay and sand. Roll the tarp back and forth until they are mixed evenly. Don't worry about small stones. Once there is a consistent mix, add water. Next comes the fun part. Squish this mixture with your feet. (Bare feet work best.) Keep adding water and stepping, occasionally rolling the tarp over to get a good mix, and throwing a few handfuls of straw in near the end. Be careful not to add too much water—the mixture needs to have some resilience so that it can be stacked, not poured. With an ideal mix you should be able to form a loaf like you would with bread dough.

You'll need a foundation to raise your cob structure off the ground—10 inches (25 cm) or more between graded earth and cob is recommended. For a foundation, stacked stone or brick will work in many cases. In general, you'll want a height-to-width ratio of 10:1 for load-bearing walls. (For example, a 10-foot-tall cob wall needs to be at least 1 foot thick.) Nonload-bearing walls need not be as thick—about 6 to 8 inches (15–20 cm). With materials at hand and some experience, one person can build about 25 linear feet (3.7 m) of wall, 12 inches (30 cm) thick and 4 inches (10 cm) high, in a day. We never achieved more than three layers in a week (about 1 foot; 30 cm in height).

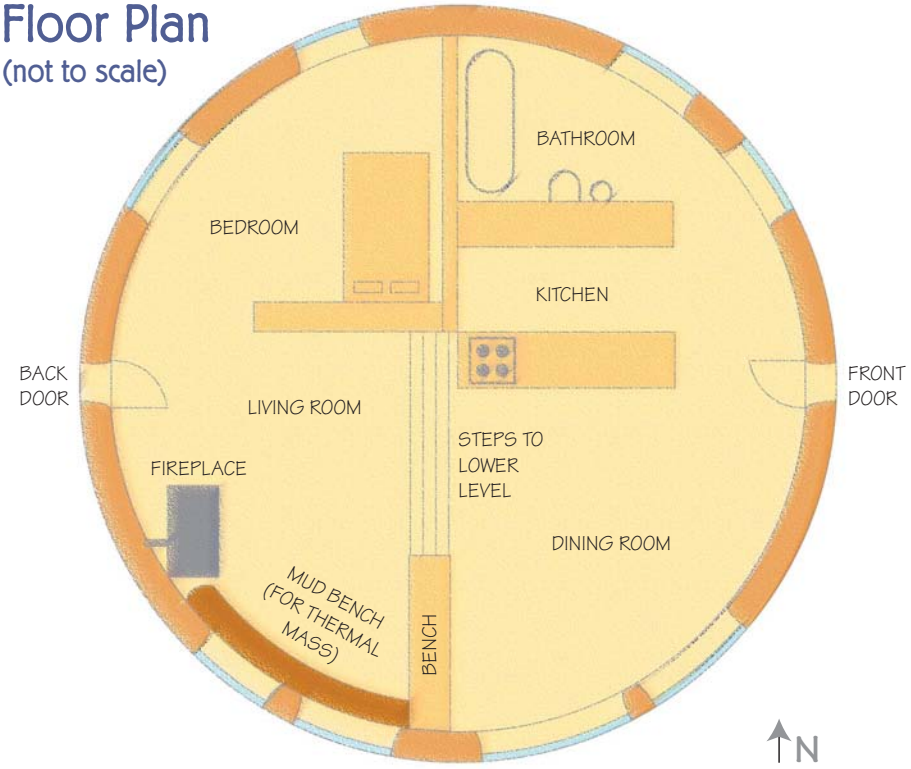
Depending on the weather, it takes a day or two before the cob hardens enough to add another layer. Keep the newly formed cob walls out of direct sunlight by placing a tarp over them; if the wall dries too fast it will crack. After three or four layers, we would even out the lumpy sides using an old handsaw and a level. Building with cob is slow but pleasant work, and is more enjoyable with friends.

Legit Permit

Somewhat reluctantly, we ended up going through the county inspection process for our home. Our inspector turned out to be reasonable and, instead of requiring us to have the plans stamped by a local engineer, allowed us to use Pima County, Arizona, building codes that detail "monolithic adobe." He also allowed us to live in our house while we were finishing it.

Although it was difficult and increased the length of the project, in the end it was well worth it. We have none of the constant worries that friends who live in uninspected houses have. By blazing a trail, we hope to have made it easier for others to build with natural materials. And we are able to get some publicity and host open houses, increasing our community's awareness of this inexpensive and beautiful building material.

Floor Plan
(not to scale)



Cob Home Costs

Construction	Cost (US$)
Poured slab foundation, 32 ft. diam.	$4,000
Lumber, roof & floor framing	2,000
Lumber, floors & cabinets	1,000
Misc. paint & hardware	1,000
Sand, 45 tons	750
Cement mixer	500
Roof tin	500
Kitchen & bath fixtures & plumbing	450
Tin ceiling, recycled, 400 sq. ft.	400
Sheetrock for ceiling, 400 sq. ft.	300
20 bales of straw	50
Clay (from excavation), equal parts to sand	0
Tarps (recycled)	0
Bead board for interior walls (salvage)	0
Labor, 2,000 hrs. (author, wife, friends)	0
Total Construction Costs	$10,950

Other

PV system, 310 W (incl. appliances)	$6,000
Driveway & septic	2,000
Well	1,200
Total Other Costs	$9,200
Grand Total	$20,150

Access

Stephen Hren, 314 Street's Store Rd., Triple Springs, NC 27574 • 336-504-4452 • themudranch@yahoo.com

Industrial Nanotech Inc., 801 Laurel Oak Dr., Ste. 702, Naples, FL 34108 • 800-767-3998 or 951-324-7121 • Fax: 239-254-1381 • corporate@industrial-nanotech.com • www.industrial-nanotech.com • Nansulate insulative coating

Adobe codes available through Southwest Solaradobe School, PO Box 153, Bosque, NM 87006 • 505-861-2287 • adobebuilder@juno.com • www.adobebuilder.com

The Cob Builders Handbook, by Becky Bee, 2000, Paperback, 178 pages, ISBN 0965908208, US$23.95 from Groundworks Publishing, PO Box 381, Murphy, OR 97533 • cobalot@cpros.com • www.beckybee.net

The Hand-Sculpted House, by Ianto Evans, Michael G. Smith & Linda Smiley, 2002, Paperback, 384 pages, ISBN 1890132349, US$35 from Chelsea Green Publishing Co., PO Box 428, White River Junction, VT 05001 • 800-639-4099 or 802-295-6300 • Fax: 802-295-6444 • info@chelseagreen.com • www.chelseagreen.com

Why Buildings Stand Up, by Mario Salvadori, 2002, Paperback, 328 pages, ISBN 0393306763, US$15.95 from Norton Publishing, W. W. Norton & Co. Inc., 500 Fifth Ave., New York, NY 10110 • 800-233-4830 or 212-354-5500 • Fax: 212-869-0856 • www.wwnorton.com