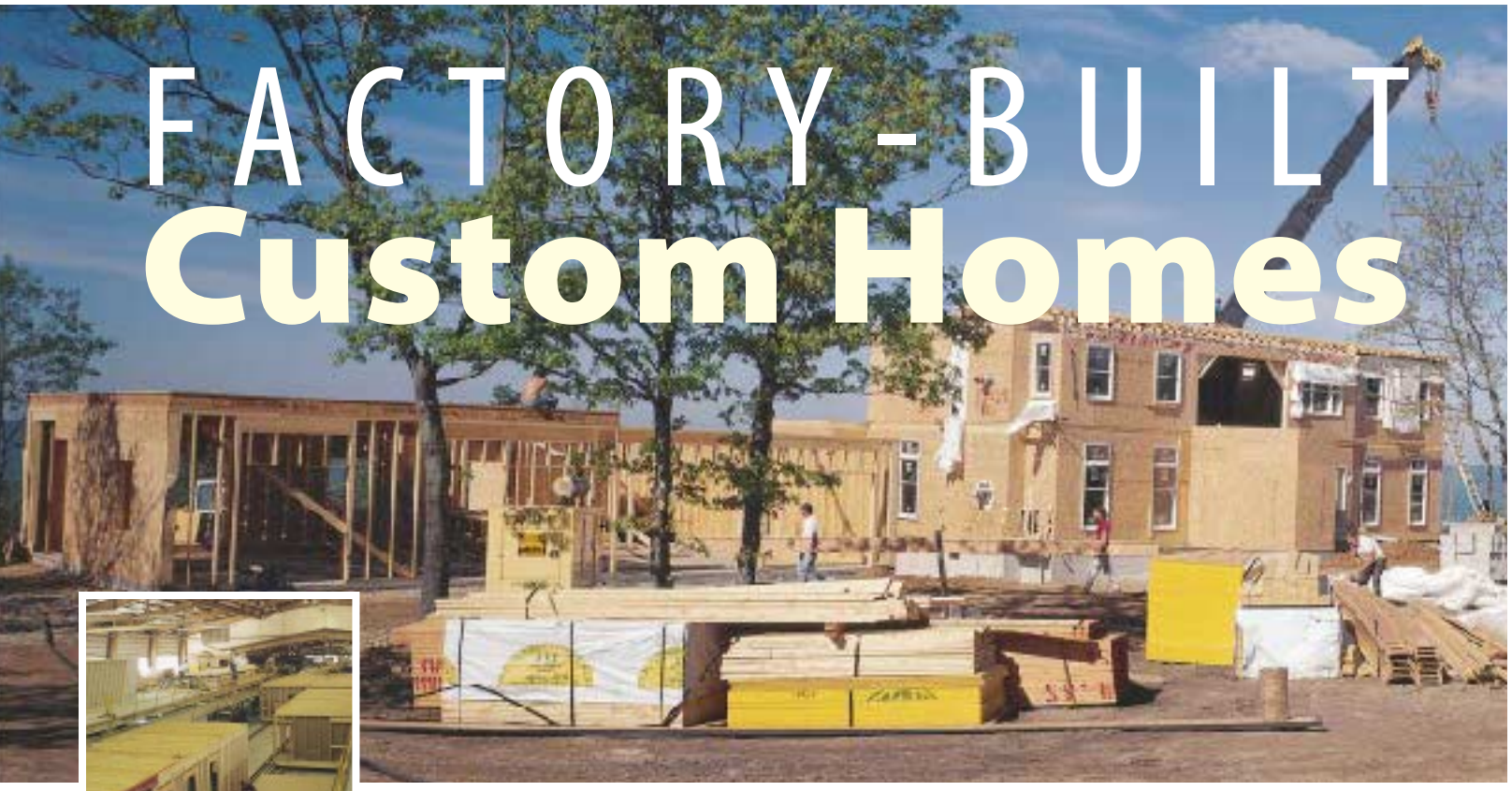
FACTORY-BUILT Custom Homes



Careful planning, a controlled environment, and a shorter schedule make modular construction an attractive alternative to stick building

by Lyle Rawlings

My company designs and sells custom solar homes. Soon after we started up in 1988, we realized that while our homes were less expensive to own over the long term, they were more expensive to buy because of the difficulty of building unique solar features on site. It was also a challenge to control quality while building houses across a six-state area. When we added it all up, modular construction was the solution.

Modular, Not Double-Wide

Don't confuse framed modular housing with other forms of factory-built housing. Like "double-wides," which are essentially inferior mobile homes built on a steel over-the-road frame, modular housing is built in a factory, but that's where the similarity ends. A modular home contains exactly the same components you would find in a stick-built home, right down to the plumbing fixtures, so you have the same range of choices in quality and price.

As a custom builder, the trick to using modular housing is finding a manufacturer who will work with you every step of the way, building the house to your specifications. The use of premium materials in a tightly controlled construction environment adds up to a house that looks as good as anything you can produce on site, but is, in my opinion, of higher overall quality.

The Modular Advantage

Once you get by the notion that modular homes are cheap imitations of the real thing, there are tremendous advantages to building houses in a factory. Almost every production problem

Figure 1. Each modular section is restricted in size because it has to be transported over the road (top). A good factory, however, can incorporate custom features, like vaulted ceilings (above), to produce a finished home that looks like it was site-built.

site builders battle can be minimized or eliminated altogether by using factory-built units.

Quality control. On most construction sites, it's a stretch to say that quality is managed at all; defects are handled with a seat-of-your-pants approach. By contrast, in a good modular home factory, each step in the construction process is carefully planned and closely monitored. Over time, all of the problem areas are identified and the solutions incorporated into all future work.

Good working conditions. Modular home plants are comfortable, safe environments for workers. Heavy lifting is done with machinery, all tools and equipment are well organized and close at hand, plus the climate is controlled. It all adds up to happier workers and better quality workmanship.

Materials stay dry. When was the last time you built a house that didn't get soaked by rain or snow once or twice before it was done? Modular homes are built indoors and never see a drop of rain. Expensive materials aren't subjected to extremes in humidity or temperature, so expansion and contraction problems are minimal.

Nothing left to chance. Stick builders tend to solve problems on the fly, making changes to the design as necessity arises. While the flexibility can be nice in some circumstances, unplanned changes can cause problems in a complicated design or tricky site. With modular construction, almost nothing is left to chance. By the time construction starts, nearly every decision that *can* be made *has* been made. When the home arrives at the site, it's a simple matter of checking a list of options and product selections to make sure everything the client purchased is included.

Warranty support. A warranty is only as good as the company that offers it. Stick-builders can provide warranties, but they may not have the resources to make good when problems arise. The plant we work with — AvisAmerica Homes in Avis, Pa. — offers a ten-year structural warranty and stands behind all of its engineered components, like trusses, beams, and in-place wiring and plumbing. If something goes wrong, I only have to deal with the factory, not a long list of independent subs.

Less overhead. Because modular homes are nearly complete when they're delivered to the site, we are responsible for just a small part of the total labor. It's possible to manage a fairly large operation with only a few employees or a couple of reliable subs.

Shorter schedule. On most of our jobs we use the Superior Wall precast foundation system (see "Fast Precast Foundations," 7/97). Combined with modular construction, this means we can actually have a house sitting on the foundation and dried-in a couple of days after construction starts.

Cost. A turnkey modular house typically costs 5% to 20% less than its stick-built counterpart. That frees up cash for materials or fixtures, such as jetted tubs or granite countertops, that clients could not otherwise afford. In

our case, we apply the savings to photovoltaic solar equipment and other solar design features, so the payback period is zero years. Because we're able to bring the house to market for exactly the same price as a conventional house that doesn't have the energy-saving advantages, it's an easy choice for our clients.

Selecting a Manufacturer

The most important element in modular construction is selecting the right manufacturer. Not all factories are set up to deal with custom builders, so you need to do your homework. Here are some factors to consider.

Flexibility. The typical factory-built home sticks out like a sore thumb because it lacks detailing, but custom builders need to provide a custom product. This can be tricky with a factory-built home because, whether it's a small ranch or a mansion, it's built on a factory assembly line in sections, or "boxes," that have to be transported over the road. This limits the dimension of each box to 14 feet wide by 11 feet tall, so the manufacturer must be willing to build the house the way you want it within these size restrictions (see Figure 1). For example, our solar homes have wide overhangs, many two-story vaulted spaces, entire walls of south-facing glass, special electrical wiring, and other elements you won't find at the local modular home dealer. But Avis has worked with us to incorporate these custom elements into its assembly-line process.

The factory should also be willing to use the materials you specify. For example, you should be able to choose between OSB and plywood sheathing, select a particular brand of window, or specify a certain type of ceramic tile flooring. It's also important to work with a manufacturer that will ship matching finish materials loose for field crews to install.

Help with design. Nobody understands what can and can't be built in a factory like a good in-house design department with CAD stations and a knowledgeable staff. Their job is to help you translate your custom work into the factory environment. Over time, Avis has developed many workarounds to accommodate our special design features, such as cathedral ceilings, catwalks, and two-story glazed walls, at a much lower cost than we could build the same features on site.

Factory support. The factory rep is your link between your customers and the final product, and a good one is worth his or her weight in gold. Our rep at AvisAmerica is Kurt Smith, who has an Associates degree in architecture and, more important, 12 years of modular design experience. Kurt is expert at translating our design ideas into plans the factory can build. Plus, he serves as the factory liaison for my clients.

Factory tour. Before choosing a manufacturer, spend a few hours in the factory watching every stage of production (Figure 2). If the workmanship is sloppy or the shop is disorganized, you'll know it right away. You'll also be able to determine if the factory can handle any special require-

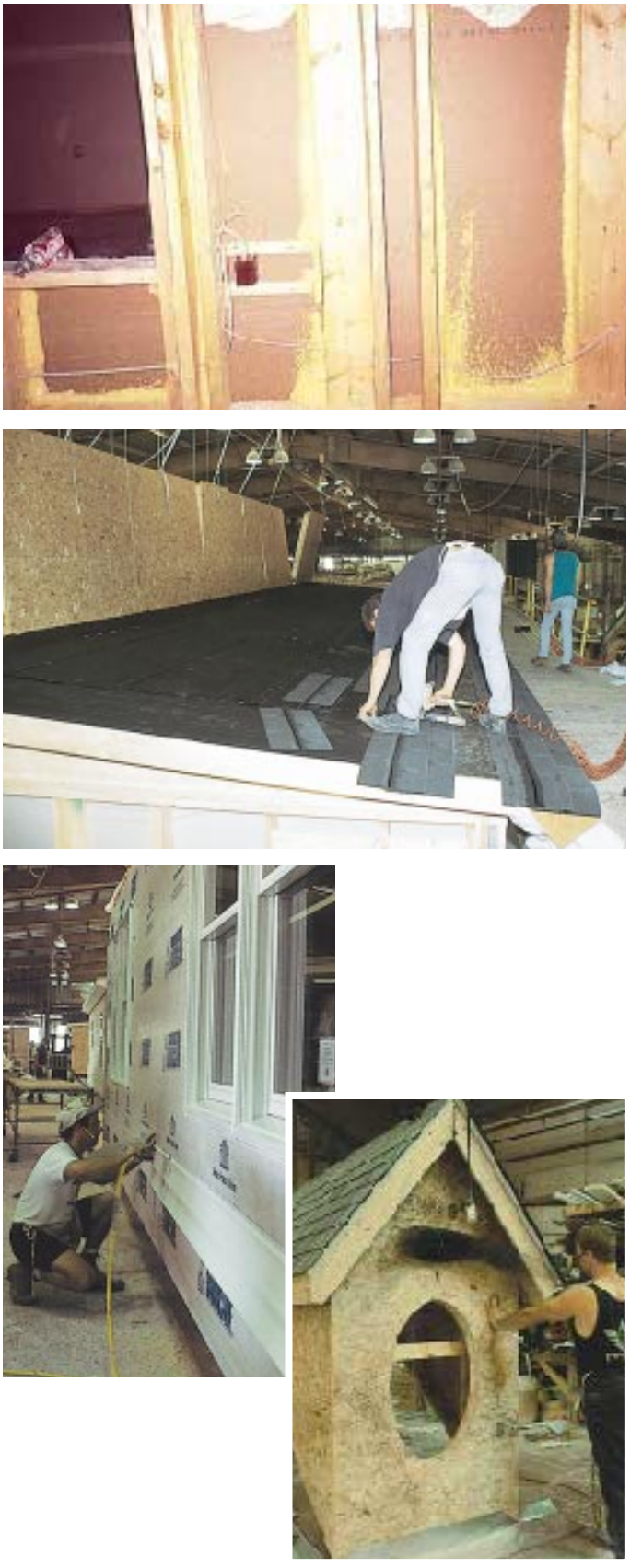


Figure 2. Each stage of construction is tightly controlled on the factory assembly line. Wall construction begins by gluing a preassembled stud wall to the drywall (top). Roofing (middle), siding (left), and framing of special assemblies (bottom) are all done inside the dry, temperature-controlled factory.

Figure 3. To take delivery, the site must provide clear passage for a tractor trailer (top). The foundation crew handles the excavation and uses a crane to place precast concrete walls (middle and above).

ments. For example, our homes require a very tight thermal envelope. Since modular factories begin with the drywall and build outward to the siding, I was able to see exactly how the insulation was installed. I also determined what needed special attention — sealing wiring holes with caulking, for example — to meet our specs.

Preconstruction

Many clients and banks have misconceptions about modular construction, so I spend a lot of up-front time explaining the advantages to both. The process I go through with clients is similar to what any other good builder does, except all decisions are made in advance of construction. Stick-builders dream about doing this, but few succeed.

I typically meet with clients several times over a period of a couple of months, finalizing the design, choosing options, and selecting materials. We use a simple checklist to preselect all colors, materials, and plumbing and electrical fixtures. I take plenty of time with customers to get it right the first time — changes to the order can be made up to the day the house goes into production, but after that a change becomes an expensive on-site remodeling job.

I maintain a simple showroom in part of my house, which itself is an example of our work. When you become a modular dealer, you'll be provided with a basic kit of samples to help clients with product selections. If you're using custom materials or want more elaborate samples (like entire cabinet face frames or window displays), the manufacturer will provide them for a nominal fee. The showroom doesn't have to be elaborate, but it does need to be clean and well organized so you can walk clients through all of the choices.

Finally, before each job is put into production, I make the 4 1/2-hour trek with my clients to take the factory tour and meet with our factory rep.

On-Site Work

Although a modular home is built almost entirely in the factory, some work still needs to be done on site. My company usually serves as both designer and dealer, and when we're working locally, we prepare the site and help the factory-authorized "set crew" place the building on the foundation and button it up. When we sell in an area that's more than a couple of hours away, we help the clients choose local contractors who contract directly with them but who work under our supervision.

When the home is ready to be shipped to the site, we work with the factory transportation manager to ensure that all roads into the site are passable, and that the driveway and the area surrounding the house are roomy enough for the heavy equipment needed to place the modules (Figure 3). In our area, Superior Foundation provides the excavation and a crew to assemble the precast foundation to our specifications.

After the modular sections arrive, the set crew unwraps them and supervises the crane that lifts them onto the foundation (Figure 4). At the "marriage wall" where two boxes meet, the set crew bolts the doubled end joists together and supports the joint with heavy-duty adjustable steel columns. In a more complex house, a steel girder may already be in place at the foundation to support the boxes.

For shipping, the eaves end of the roof is hinged at the top of the wall and folded flat on top of the box. Heavy-duty steel strapping serves as both the hinge and as a wind-resistant hold-down once the roof is in place (Figure 5). Upper sections of the main roof planes are also hinged and folded back on the lower section, as are rake overhangs and extra-long eaves. After the boxes are set, the crane lifts the hinged

Figure 4. After the modular boxes are craned onto the foundation (top), the set crew bolts the floor systems together and supports the "marriage wall" — the common wall between boxes — using adjustable steel columns (above).

Figure 5. The roof, which is hinged and folded back on itself for shipping, is craned into place (top) and supported, either temporarily with posts or permanently with a structural ridge or preassembled kneewall. In a custom design, prebuilt dormers or second-story walls may also need to be placed by crane (middle). The last step is to weave several courses of roofing into the unfinished areas (above).

portions into place, and the set crew aligns them and installs temporary supports that will hold the roof up until the permanent collar ties are in place. Depending on the design, a preassembled kneewall may be supplied to support the roof, and prebuilt dormers and other additional roof modules may also need to be set.

The last step for the set crew is to weave roofing material into the unfinished areas. For a Cape, the entire process of setting and assembling the home takes only about eight hours. For a two-story home, the process is the same except that two second-story boxes are set on top of the first-story boxes. This work is still usually accomplished in one long day.

Mechanicals. Heating, electrical, and plumbing systems are roughed in at the factory to our specifications, with stubs left in the floor joists for site connection in the basement. The plumbing and lighting fixtures selected by our clients are also installed at the factory and are ready to go when the house arrives. Once the house is set, local mechanical and electrical subcontractors connect all the piping in the basement and complete the wiring to the service panel. The heating contractor supplies, installs, and vents the boiler or furnace, which is never part of the factory package. The electrician also connects our photovoltaic equipment.

Figure 6. Once the modular sections are set and buttoned up, the author's crew completes special features, such as radiant heating (top) and photovoltaic panels (above), on site.

Finish Work

While the factory can frame and finish interior partitions, sometimes this work has to be performed on site — second-floor framing in a Cape, for example, which has sloped ceilings. We've also been satisfied with the way Avis installs window and door trim, so we have all of the trim applied at the factory.

But because of the custom nature of our designs, we prefer to do certain types of finish work on site. For instance, we typically have our houses delivered with the drywall taped and primed, but we apply the final coats of paint once everything is buttoned up. We also specify that all the finished flooring be done on site, because we use lots of radiant heat and ceramic tile flooring in our projects (Figure 6). The same is true for wood siding, which moves around too much during transport and isn't as forgiving as vinyl. We install high-end countertops, such as granite, on site as well, although the factory hangs all kitchen and bath cabinets, and installs all fixed appliances and laminate counters. We also install stair railings and trim for the marriage walls, although the factory supplies precut and prefinished material.

On our projects, we sometimes install roof-mounted solar panels for electric power or hot water before the roof is lifted into place; other times, we wait until the roof has been hoisted into place. Because all of the interior electrical work is done in the factory, installing photovoltaic panels as soon as possible enables us to turn on the power even if the utility company is nowhere to be found. We can use the ceiling lights and plug our tools and radios into outlets instead of having to provide generators and snake extension cords around the house.

After the set, we go through the house with the local contractor and the buyer to check for damage and to determine whether all the items ordered from the factory were shipped or built in as planned. We expect to find some drywall cracking and other minor damage, and the local contractor usually makes the repairs. Any missing items or incorrect construction, and any repair of unusual damage is generally done by the factory using its own crews. The factory provides a one-year warranty on all of its work, plus a ten-year structural warranty. Depending on where the house is built, we or the local contractor may have additional warranty responsibility, just as if the house had been site-built. When the owners are ready to move in, we inspect the work the local contractor has done to complete the project, and work with the owner to resolve any defects.

Lyle Rawlings *is a licensed engineer and the owner of Fully Independent Residential Solar Technology, a designer and dealer for custom solar homes in Hopewell, N.J.*