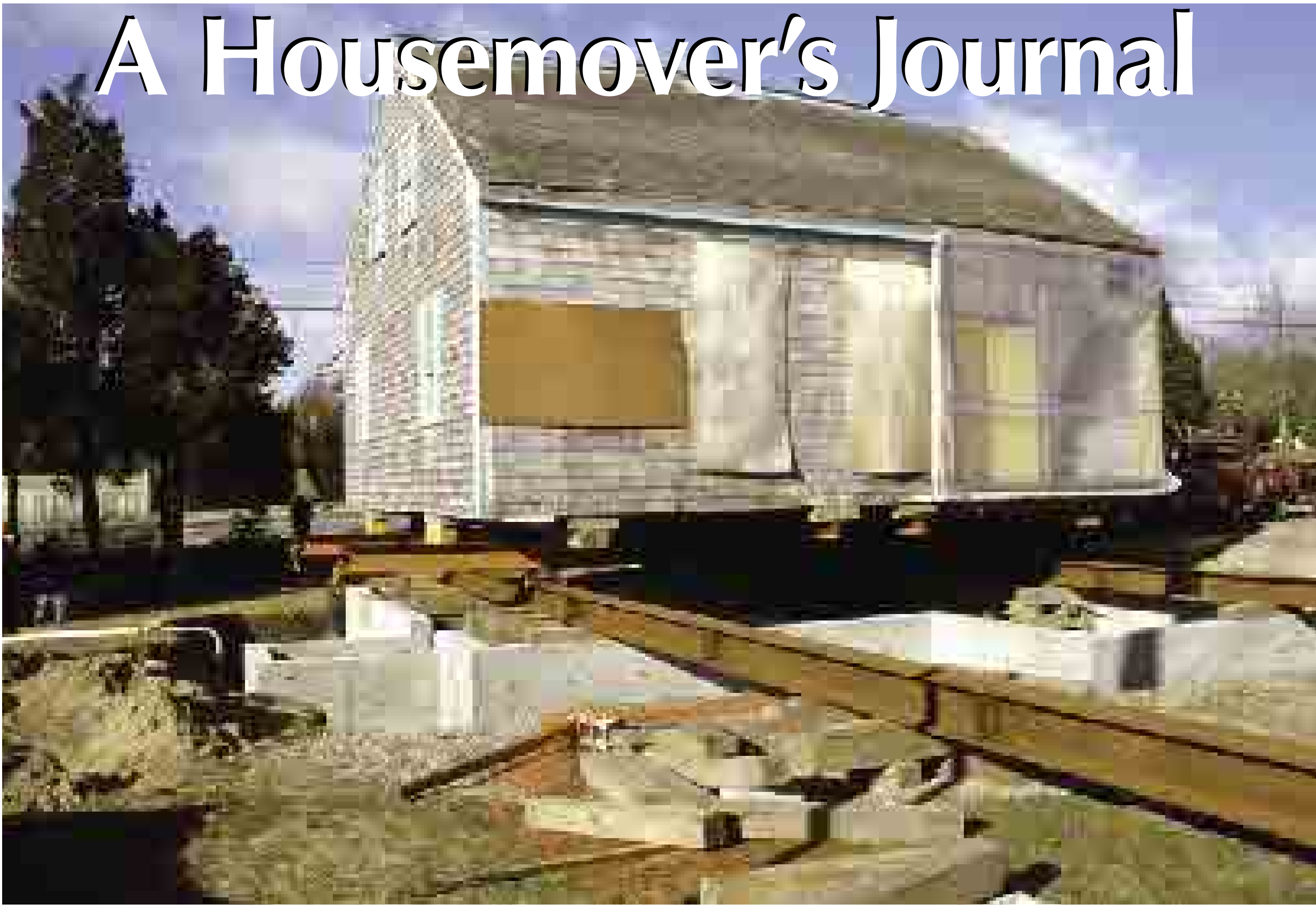
HEAVY LIFTING

A Housemover's Journal



"Move it or lose it" is a call to action when an antique home outlives its prime location

by Robert Hayden

Even though I move buildings for a living, not every old house is worth saving. Once you factor in the expense of preparing a building for lifting or moving, and the cost of the actual lift itself, it may well make more sense to demolish and start new. But, fortunately for my business, there are also enough good reasons to salvage an older house. For example, in order to add a second story to an existing building, the builder must prove that the foundation can handle the added structural load. If the foundation fails on analysis, replacement is a common option, facilitated by raising the house. Then, there are older houses of good quality that are sold cheaply to be relocated to a new site. With some cosmetic repair and reconnection to utilities, these houses get a new lease on life. And, occasionally, a house is defined as a valuable antique and worthy of preservation, even if it means a delicate and expensive relocation. That was the case with a recent job we undertook moving the ancestral home of the Nickerson family, a classic Cape Cod house, across town and onto a new foundation. The house was not large, measuring 25 by 31 feet, with a small kitchen ell that could be cut away and moved separately. The main structure, however, had to remain intact. But

Figure 1. The house originally stood only inches above grade on a low brick perimeter, with intermediate wood posts at key framing junctions in the floor system. With the exception of a circular root cellar under the ell (above), there was virtually no clearance below the joists. In spite of this, the wood was in remarkably good condition (right).

it's one thing to move a house built in 1972, where standardized construction makes the process predictable. This exemplary post-and-beam house was built in 1772, and there was nothing at all predictable about moving it. Nonetheless, it provides a good extreme case study.

Evaluating the Structure

One of the first steps in evaluating a building for lifting is to check the condition of the building's underpinnings — the perimeter sill and floor joists. In this case, that meant hand-digging a few exploratory holes to inspect the framing over the marginal crawlspace foundation. The foundation was a double-wide course of locally made brick, laid about six high directly on grade. The stable, free-draining sandy soil on the site has to be credited with the exceptional condition of the oak sill and floor joists, which had only inches of clearance above the roughly leveled grade (see Figure 1). This was an unexpected piece of luck, as the rotfree framing would allow us to proceed conventionally by lifting from underneath the sills and floor system. Otherwise, contrary to preservation efforts, we'd have to destructively alter areas of the antique structure in order to lift the building by its walls (see "Extreme Lifting," page 8).

Although I determined that the building could be safely lifted, the owners, who planned to open it to the public as a fully functioning period-style home, didn't want to proceed unless the original central brick chimney could also be lifted intact. This was a far dicier proposition. The chimney was actually made up of three back-to-back fireplaces with individual flues and an unusual beehive oven, all in fragile condition. I pulled out nearly 40 loose bricks, fallen from who knows where, simply by reaching up into the throats above the fireboxes.

There's virtually no flexibility or forgiveness in a masonry structure, especially not one that's stood for a couple hundred years. The owners sought an evaluation from masonry restoration specialist Richard Irons of Limerick, Maine. Irons declared the beehive oven exceptional and especially fit for restoration and further pointed out that, if demolished, it could not be recreated because its construction did not meet current code clearances and guidelines. With this encouragement, I had to decide on the best way to shore it up and lift it intact.

The building would be taken over the roads and had to clear tree limbs and power lines. Even without the masonry above the roofline, I'd be working with a 26-foot clearance height, including the 25-ton-capacity dolly wheels, something that must be considered when moving a building over the roads and under electrical utility lines. This part of the chimney was far too deteriorated and fragile to consider saving anyway, so we took it down to a point just below the ridge where it was bracketed by the roof framing. We saved all of the bricks for Irons's later use in reconstruction. Underpinning the chimneys for lifting was the really tricky part. First, I had to determine what I had to work with.

Reinforcing the Chimney Mass

There's nothing structural about the brick hearth or floor of the firebox, so we removed these bricks to expose the chimney underpinnings. As expected, there was no actual base pad; instead, the three flues rested on a platform of dry-laid field stones, set in sand. Behind the walls above the fireboxes we found more trouble in the old, crumbly mortar. Gravity alone was holding everything together.

To prevent the bricks from shaking apart during the move, we applied a sticky "skin" of rich masonry cement, reinforced with embedded chicken wire, to the fireboxes and brick above the lintels (Figure 2). Simultaneously, we selectively removed field stones and earth from the sub-hearth area. With the foundations of all three fireplaces now somewhat exposed, we beamed a laser level from one firebox to the next

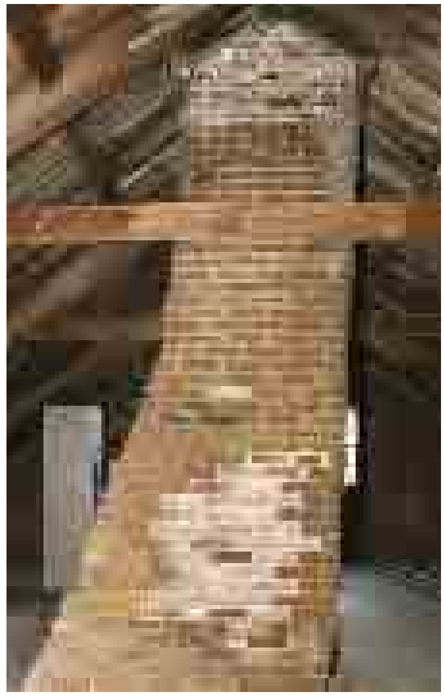


Figure 2. A parge-coat of masonry cement held the bricks steady for lifting and transportation (above). Restoration efforts included making a temporary access hole (shown patched in the photo at right) to send a small mason inside the chimney to repair and reline the three throats and flues.

Figure 3. While the author swings a two-ton main beam into position with the backhoe, a worker makes sure the far end doesn't take out the neighbors' place across the street.

and established a common, uniform level to work to. After spreading poly sheeting on the ground to prevent earth bonding, we reinforced the hearth area with 2-inch steel box tubing and rebar set on chairs, then filled the excavated area with a 4-inch-thick pour of 5,000-psi, site-batched concrete. We used a sand mix without stone aggregate to ensure good flow and penetration of the interstices between stones and bricks. I was hopeful that this temporary base would integrate the three chimneys and beehive oven sufficiently for the subsequent jacking operation. Before proceeding, we allowed the concrete to harden for about a week.

Placing the Beams

One of the many challenges to raising an existing building from its foundation is access. A steep or otherwise limited site increases the difficulty and therefore the cost of lifting. It's a definite plus to have clear, open space around the building to insert the long, 12x12-inch steel H-beams and wood cribbing that provide the main lifting support (Figure 3, previous page). Happily, access was not a problem on this job. There was plenty of room to maneuver a backhoe and dig starter trenches and cribbing pits for the two main beams at the building's gable ends. We completed the trenching under the house by hand, digging deep enough to account for the combined depth of the main beams and the crossing "needle" beams, the tops of which had to plane out coincident with the underside of the chimney slab we'd just poured. This point was about 18 inches lower than the sill.

Ordinarily, lifting a house of this size takes a pair of main beams and four 8x8-inch needles — one on either side of center span and one under each outside

Steel Beam Layout

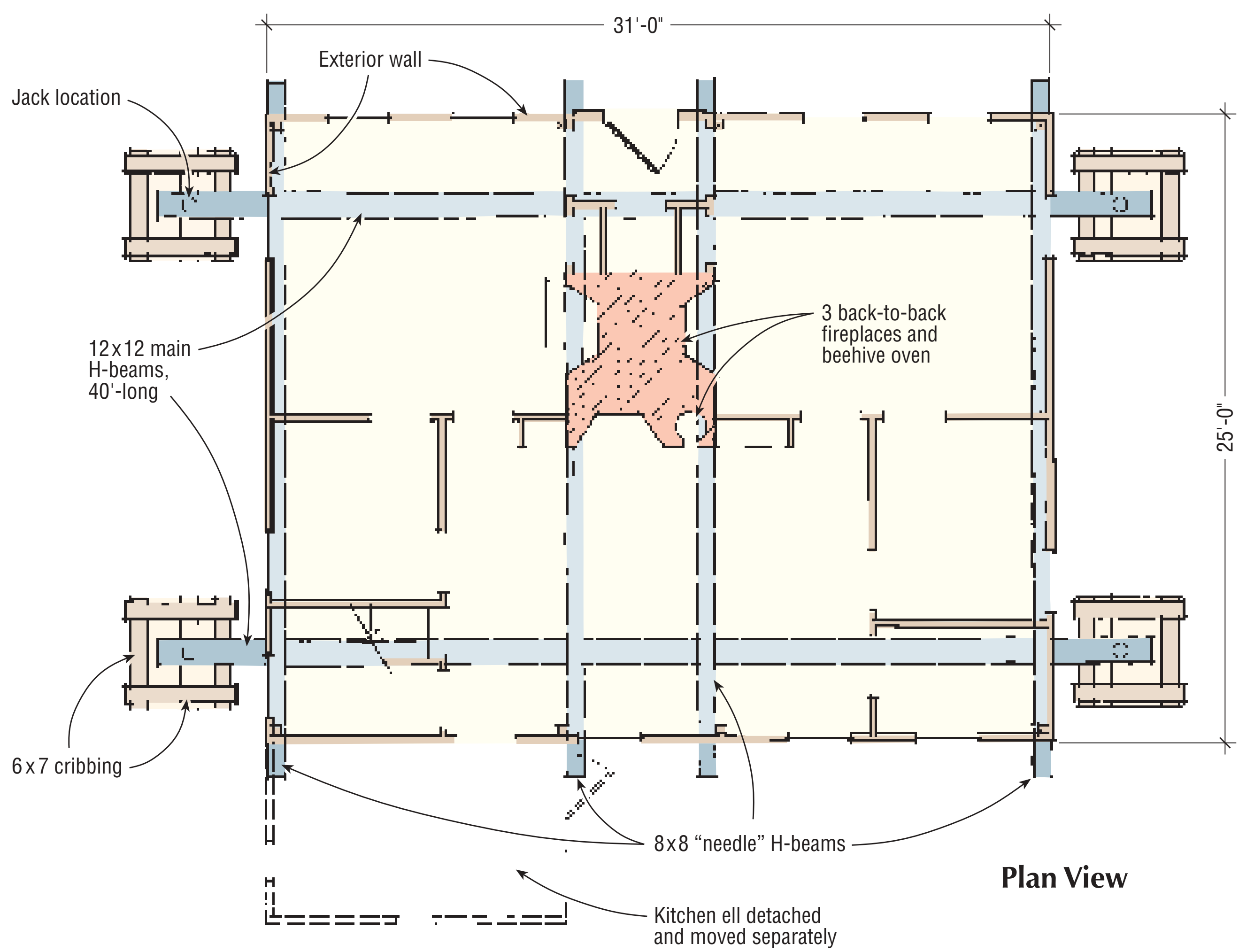


Figure 4. Two main beams and four needle beams supported the house for lifting. To avoid deflection from the masonry load on the main beams, the author placed the needles under the chimney mass first.

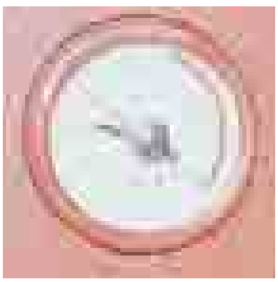
bearing wall (Figure 4, previous page). The needles either go in tight against the floor joists or, when a chimney lift is involved, are inserted below the hearth slab at a lower level than the sills and shimmed between their tops and the underside of the floor joists. The shims we use are various blocks of wood, from 8x8 off-cuts on down to cedar shingles. Compressible rigid foam board also comes in handy for cushioning the pressure points and filling irregular gaps.

Pre-loading the chimney. On this job, we inserted the center needles under the chimney mass first (Figure 5). We slid the first one in and jacked it snug

Figure 5. After carefully removing every other stone supporting the three chimneys and pouring a unifying reinforced concrete slab between them, the author slipped two needle beams beneath the masonry, initially jacking them just enough to transfer the load.

Figure 6. Rollers facilitate beam placement under the structure. The beam is chained to the backhoe bucket to keep it from launching itself forward like a battering ram.

Figure 7. Four-foot lengths of 6x7-inch timbers are stacked to support the main steel H-beams. To ensure stability, the cribbing must be shimmed or shoveled dead level (above). One layer is blocked solid to support the jack (right). The unified jacking system manifold also provides an instant readout on the weight each jack lifts (below).

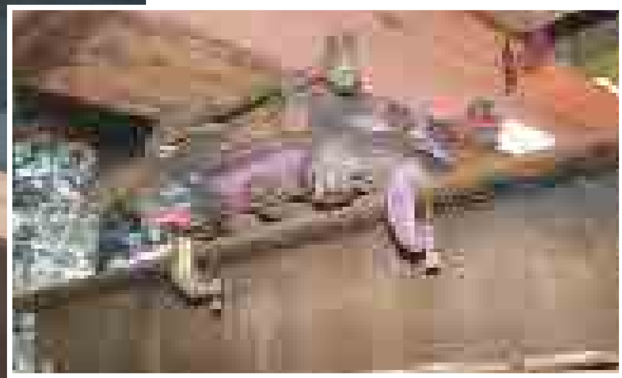


against the modified chimney base, so that it began to shoulder, but not raise, some of the masonry load. Then we inserted the second needle and snugged it up, too, effectively transferring the full weight of the chimneys onto the needles. Usually, you'd place the main beams, then set the needles; but then, this wasn't a usual case. Despite the overall bearing capacity of the H-beam needles, there is still considerable mid-span deflection under a masonry load, which moves independently of the wood structure. We accounted for that deflection by transferring the chimney weight first. Lifting the building was then a matter of placing 40-foot-long 12x12-inch main beams under the center needles, installing the outer needles, then shimming as needed.

We chute the beams in on rollers set on low cribbing stacked just outside and just beyond midway inside the foundation (Figure 6, previous page). My derrick usually does the heavy work — a 40-foot H-beam weighs 3,600 pounds — and also pivots the far end of the beam up or down to clear the floor by using the outside roller as a fulcrum. There's always a man under the house keeping an eye on the blind end of the beam and shouting directions.

Up We Go

Cribbing supports the four ends of the two main beams and must be installed completely level for stability. It's retrofitted under the beams, crossing 6x7 members two on two in a box configuration (Figure 7). The remotely controlled, unified system jacks are placed on a solid layer of timbers placed within the cribbing. Once the cribbing is built as high as possible under the beams, the jacks are individually activated at the central manifold while lookouts call out local conditions at the jacking stations. Any telltale creak or shifting is cause for a halt and possible correction before proceeding. The jacks raise the building in 14-inch lifts, allowing the cribbing to be stacked progressively higher, up to the point where the building can be rolled



off the foundation and placed on the dollies (or, if it's going right back onto a replacement foundation, more cribbing). Gauges for each hydraulic line provide feedback on the jacks' lifting force, telling me how much weight each is picking up. All told, this building weighed 35 tons, a relatively light load in moving terms.

To roll the building off (or on) the foundation requires another set of track beams, set perpendicular to the main beams and supported at intervals on cribbing and the foundation itself. The main beams ride on the track beams on heavy-duty bidirectional "skates" (Figure 8).

On the Road Again

It's getting more difficult all the time to take a building over the roads. Local regulations and permits are one hurdle to overcome. Cooperation from power and cable utilities is a whole other process with little predictability except for the aggravation involved. Those considerations aside, on reviewing the prospective route for this move, it became obvious that there would be no practical way to move the building intact through the tight turns and narrow restrictions along the way. However, an alternative route presented itself in the surrounding

Figure 8. Two-way Hevi-Haul skates (top), are used to roll a building on or off the foundation as well as for alignment above a new foundation before lowering the house into place. Here, the house is winched forward on one axis (above) and nudged into position with a derrick arm on the other axis (left).

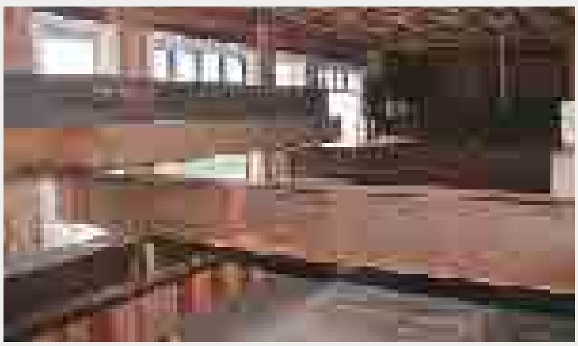
Extreme Lifting

In 2003, we raised a large new house still under construction. The builder was blind-sided by a misinterpreted order of conditions for installing a foundation on a coastal dune. Coastal dunes are generally dynamic formations shaped by wind and waves and provide a natural line of defense against catastrophic beach erosion. Therefore, any proposed building on a coastal dune must conform to strict job-specific conservation regulations. Unfortunately, this project was well under way and tight to the weather when the stop-work order was issued. After long delays and legal wrangling, a solution was reached stipulating that the foundation must be modified to allow dune sand to drift naturally under and around a portion of the building. Instead of a continuous, solid wall, the foundation was to be replaced in part by regularly spaced wood pilings tied to existing helical footings. In addition, the building's elevation was to be raised by about $2\frac{1}{2}$ feet. Of course, this revision turned out to be much easier said than done.

We were forbidden to dig access holes around the foundation to insert the large steel I-beams needed for lifting under the sills. That meant that we had to work from inside the foundation instead, break through the floor at strategic locations, and lift the house by its walls using temporary, nailed-on ledger boards. It also meant that the I-beams would have to be fed in through existing door and window openings. The house measured 135 feet along its delta-shaped length, was 60 feet at its widest point, and incorporated a masonry fireplace and chimney that the builder and homeowner wanted to preserve intact. Not only that, but there were many expensive teak windows already installed that we'd have to take pains to protect from breakage.

To make a long story short, we prepped the house for lifting from seventeen separate jacking locations (in contrast to the average of four to six), then I called on a colleague, Norman Messier of East Montpelier, Vt., to supplement my 6-jack machine with his 12-jack machine. After cautiously nudging up each jack in turn to test the system and listen for telltale structural creaks and groans, we raised them all in unison, ultimately lifting the structure almost 5 feet. The hydraulic gauges registered an aggregate load of 175 tons. Three weeks later, we lowered the building $2\frac{1}{2}$ feet onto the modified foundation without a single broken window or a crack in the chimney. I slept pretty well that night.

— R.H.



Ledgers nailed across studs (right) provided lifting points for steel beams, which were fed in through window openings (below, left). Because coastal regs prohibited digging around the perimeter of the house, cribbing had to be stacked through the floor joists with the subflooring removed (below, right).