Road Map for High Performance Home Building
(or)
High Performance Building:
Where Do You Start?

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To successfully build high-performance homes, builders must be willing to make fundamental changes in their operations. (Duncan Prahl, IBACOS)

We have met the enemy and he is us. (Pogo, the cartoon strip)

"Okay, we're seriously interested in moving towards building high performance homes, but where do we start? What's the process?" Two large Colorado builders asked E-Star Colorado these questions last year.

This interest stems from the perceived risk-management, liability reduction and quality reputation benefits that accrue to builders taking the systems approach to design and construction. But while those benefits beckon, both the perceived costs as well as the process headaches of this transformation can be flat-out intimidating.

Pittsburg-based IBACOS, Inc. (Integrated Building and Construction Solutions), a U.S. Dept. of Energy Building America Program team leader, has been researching these process questions for two years. While assisting several large production builders in Denver and across the country in making their organizational transitions to high-performance home building, IBACOS' Duncan Prahl has been documenting what works, what doesn't, and why. What follows is an overview of his preliminary recommendations. (For more detailed info, tap the "Information Resources" section.)

The big barrier

In IBACOS' experience working with large builders, internal organizational structures and processes are primary barriers to widespread adoption of high-performance home principles, practices and construction techniques. It takes fundamental change, often top to bottom, in order to make the transformation. Change isn't easy. Buy-in is needed at every level.

Do not "pass go" if…

Prahl states bluntly, "Builders have to have a certain level of rigor—reasonable control over basic homebuilding skills and process—before they can adopt a high performance home approach." Using NAHB Research Center's Quality Self Assessment Tool, he recommends that any builder should qualify at Level 3 on the National Housing Quality (NHQ) Rating Table as their starting point.

To find out where you stand on the NHQ scale, go to the IBACOS website and find either of the two documents listed under "Information Resources" below. Both contain the NHQ evaluation tool with IBACOS' suggested modifications.

A key ingredient

When transitioning to building homes that feature the systems approach to health, safety, durability, comfort and energy efficiency, nearly all builders need some outside help plus a designated in-house leader.

"A home performance specialist (HPS) supports builders who want to implement high performance standards in their organizations," writes Prahl. "An HPS is an individual trained in building science, design engineering principles, and general residential construction techniques. They lead or facilitate various initiatives through the design, purchasing, and construction process to ensure that the finished product meets the builder's standards. We believe that a network of HPSs needs to be developed in order for widespread market transformation to occur."

Initially, these specialists are outside individuals such as advanced home energy raters, or support teams such as Building America. Additionally, an in-house person or small group should be designated the lead and be given sufficient support at top levels within the organization.

Back in 2001, Engle Homes worked with a Building America, but they dedicated new-hire Gil Rossmiller early on to track and assist the in-house transformation. At Aspen Homes, it was initially energy rater Jammie Sabin who played that role. At Oakwood Homes, in-house designer Don Carpenter and Director of Operations Les Andersen took the early lead with support from Paul Kriescher at Lightly Treading Inc.; they recently sent two staffers to the E-Star rater training in order to develop in-house building science expertise and to optimize their performance-testing budget.

An Eight-Step Path

The key processes and operations that IBACOS identified as needing development and documentation by builder teams moving toward high-performance building are the following.

1. *Set performance standards.* IBACOS finds that, beyond meeting minimum code requirements, very few builders have written performance standards. Too often, existing standards may be designed to protect the builder or trade contractor against homeowner claims rather than to ensure better home performance.

A systems builder needs a set of standards that can be distributed to all internal and external team members, defining performance target expectations (see sidebar for abbreviated list). This shows vendors the builder's commitment to high performance. It means that all parties will need to play their role effectively in order to achieve the overall objective.

[INSERT A SIDEBAR OF SAMPLE STANDARDS HERE; (see end of article)]

2. *Audit existing products.* Builders and their trades need to know how their current-practice homes perform. A brief but thorough period of performance testing and product evaluation will supply the essential baseline information, identifying the gap between how their homes perform today and the new performance standards.

3. *Develop an integrated design process*. As new designs are developed, everyone in the design and construction teams plus purchasing, marketing, warranty, and external vendors must have a clear understanding of new performance targets associated with new product lines. Early on, builders need to work with outside architects,

designers and engineers to bring them up to speed on the new standards and possible implications. All structural, framing, insulation and mechanical systems and strategies should be reviewed for compliance and compatibility. The design process must allow for feedback early and often; that allows for early identification of potential conflicts or opportunities for alternate solutions before designs are finalized.

Prahl described the example of Denver-based Oakwood Home's integrated work with respect to their framing and HVAC. "Every stud, floor truss and roof truss must be specifically located and coordinated with the work of other trades in order to make installation of all other systems go smoothly and efficiently." Use of a 3-D CAD and panelization program allows Oakwood's framing and HVAC contractors to identify conflicts and develop solutions before houses go into production.

With respect to HVAC systems, Prahl reports that Oakwood has developed their design software to the point that they can insert duct systems into their 3-D CAD models. Potential interference between structure and ducts can be identified before construction, and solutions developed in the design phase instead of relying on "workarounds" in the field.

4. *Adjust documentation and purchasing practices*. Today's design documents are often created with just enough information to obtain competitive bids and a building permit. Going forward, construction drawings must include appropriate details for various building performance aspects of the project. Once the set is complete but prior to bidding, the purchasing manager needs to define detailed scopes of work for individual trades in order to help them achieve the company's new performance targets.

5. *Verify and enhance trade skill sets.* The initial round of testing will highlight strengths and weaknesses in key trades. At that point, IBACOS emphasizes that builders and vendors embark on a full training program that engages all levels of the companies. As the process moves forward, feedback from trades should be solicited.
Says Prahl, "The trades need to know the new methods, systems, materials and techniques necessary to meet the higher performance standards. This can entail a significant resource drain on the builder, and in many cases is enough of a barrier to prevent them from even considering raising the performance standards for their homes."

6. *Modify site supervision.* Site supervisors must inspect work by trades to assure compliance with the new higher performance standards. They will need training in order to fully appreciate the degree to which the proverbial devil lies in the performance details. They should collaborate with housing performance specialists, monitoring test results closely.

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7. *Communicate value to consumers*. Prahl states, "Most builders use price in conjunction with the visual and spatial attributes as the primary positioning of their houses to customers." The new challenge is to develop a corresponding explanation of the value of higher performance. Oakwood now provides recorded descriptions of high performance features and benefits in their model homes. Strategically placed signs encourage prospects to "push this button to hear about" numerous items.

8. *Measure financial, organizational, and building performance impacts of new systems approach*. During the transition to high-performance construction, builders need to measure how well they are doing compared to their performance goals. This requires more inspection by site supervisors plus some level of performance testing. As contractors become adept at meeting performance targets, IBACOS notes that some

builders have chosen to ramp down their testing activities, while others continue their 100% testing as a QC process. Tracking services calls and customer satisfaction scores will highlight the degree to which the switch to high-performance building has provided broad benefits.

Prioritization

If you just can't make all the performance updates simultaneously, if you can't swallow the entire transformation at one shot, what should you do first? Here's generic prioritized guidance from IBACOS, grouped by impacted trade contractors.

A. *Address combustion safety/ IAQ*. Says Prahl, "It is critical in a high-performance home that primary combustion equipment not backdraft or allow combustion products to spill back into the living space." IBACOS recommends sealed combustion or at least power-vented gas appliances. At the same time, builders should start installing controllable fresh-air ventilation systems.
B. *Address water management*. Builders must be able to manage rain, snow and groundwater on the site; minimize its ability to get into the structure; and design a structure that can dry when it does get wet. Changes often center around a good drainage plane carefully integrated with window and door flashing products.
C. *Improve thermal enclosure*. Include energy upgrades to meet your performance objective. This probably includes low-e windows, comprehensive air sealing of the building envelope, plus improved wall, foundation and attic insulation.
D. *Tighten and re-engineer ductwork*. IBACOS reports the obvious: that training, redesign and testing of ductwork requires major effort, probably more than any other single change from the average Colorado new home.
E. *Implement fully integrated design of structure and mechanical systems*. Bring all ducts inside the shell, right-size (i.e., down-size) the mechanical equipment, and apply advanced framing techniques. There's a lot to this last step. (See "Information Resources" below.)

Bottom line impact

Prahl reports that all builders will have a transitional period, moving through steps A through D above, when higher costs will be incurred. Comprehensive water management, improved indoor air quality, a better thermal shell plus a designed and tested HVAC system add cost; the amount depends on a builder's current performance package. It is only at the last step, where whole-house engineering takes place, that a builder can ring up some reductions to bring down the added first-cost of moving to high-performance home building.

But remember, once enough experience has been gained to optimize the package, the cost to a buyer to both own and operate the home (mortgage, maintenance and energy costs) should be the same or less than owning a standard practice home. At the same time, the builder will have improved the quality of their product, cut down on callbacks and reduced general product liability. This is a mountain worth climbing.

Information resources

The IBACOS website www.IBACOS.com contains two documents that provide much more background on the issues covered in this article. "Community Scale Process Research Results," 11/10/04; and "Community-Scale Evaluation Plan Report, 8/29/03.

"Building Better Homes" is an instructional DVD available from www.buildingknowledge.com. It shows design and construction techniques for building high-performance homes and describes how to transition to systems building.

Builder's Guide: Cold Climates, updated in 2004 by the Energy and Environmental Building Association (EEBA). Excellent information to help you design and build better performing homes; it includes limited process information within its 350 pages.

Water Management Guide, updated in 2004 by EEBA. A reasonably short and concise guide that helps you achieve priority #2.

Visit www.housesthatwork.com, the website for Building Science Corporation, another team participating in the U.S. Dept. of Energy's Building America Program.

Environments for Living's website _____ provides useful systems-built information.

A 12-part series of articles called "The House As A System," printed in this magazine back in 2000, and available on www.e-star.com. While somewhat dated, it provides a reasonable overview from a Colorado perspective.

SIDEBAR: **Sample performance standards**

Don't wait for the one-size-fits-all magic list of performance standards. Yet some good groups—including Denver's own Built Green Program/High Performance Home (formerly known as "Tier 2")—have put a lot of effort into developing solid lists. To save you time and minimize brain damage, use them. The lists have a lot in common, though some performance areas (e.g. water management, comfort) are either ignored or not explicit.

While the list below just scratches the surface, your own list should probably include some variation of them all:

--Combustion safety: all combustion appliances will be either sealed combustion or power-vented designs.
--Water management target, such as "no leakage of bulk water from the outdoors past the drainage plane."
--Comfort: no more than X degrees temperature difference between the warmest and coldest rooms when the furnace/boiler/AC shuts off.
--Advanced framing specs to eliminate unnecessary use of lumber and to allow optimum HVAC installations.
--House tightness spec, in either "air-changes per hour" or "air-changes at 50 pascals of air pressure.
--Duct tightness spec, expressed as "X% leakage at 25 pascals of air pressure."
--Mechanical equipment performance specs (furnace, water heater, etc.)
--Insulation spec, such as no voids or compression of product.
--…and more.

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