



## BUILDING AMERICA TOP INNOVATIONS HALL OF FAME PROFILE

### INNOVATIONS CATEGORY:

1. Advanced Technologies and Practices
- 1.1 Building Science Solutions

## Integration of HVAC System Design with Simplified Duct Distribution

Building America research team IBACOS worked with S&A Homes to design a compact HVAC layout with all ducts in conditioned space in several homes in Pittsburgh.

Poor-quality HVAC design and installation can reduce the overall HVAC system energy efficiency up to 30%. HVAC quality installation practices are essential to realizing the promise of high-performance homes.



### BUILDING AMERICA TOP INNOVATIONS

**Recognizing Top Innovations in Building Science** – The U.S. Department of Energy's Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

***Building America research has provided critical guidance for designing HVAC systems in high-performance homes with low heating and cooling loads.***

You can twist an electrical wire into a pretzel and it will still transmit electricity, but excessive bends in HVAC ducts will greatly reduce their ability to move air and will increase conductive losses. Based on this understanding, engineers with Building America's research teams have consistently counseled builders to incorporate HVAC system layout early in the design process. One team, IBACOS, has conducted considerable analysis on optimizing HVAC performance and has published its recommendations for HVAC integration in several documents, including *Advanced Strategy Guideline: Air Distribution Basics and Duct Design* (Burdick 2011).

As IBACOS states, decisions made during the early design phase will be critical to the successful performance of the HVAC system. The design team needs to allocate adequate space for the equipment and ducts while identifying potential conflicts between the building's structure and the HVAC system. When duct design is relegated to an afterthought, conflicts in the field between HVAC runs and structure usually result in ducts being lengthened, compressed, or convoluted, or framing members being cut—neither alternative is desirable (Burdick 2011).

Locating the HVAC equipment centrally within the house is an early design consideration with many benefits. It allows for shorter duct runs with similar lengths, which can lead to a better balanced system and improved performance. When the building enclosure is well sealed and insulated, supply registers that are located high on interior walls with sidewall diffusers aimed at exterior walls can provide adequate conditioned air distribution.

HVAC routing is much less flexible than plumbing and electrical. When duct layout is considered early in the planning stages, the HVAC designer can increase the distribution system's simplicity by stacking vertical chases and specifying short, direct horizontal runs. HVAC chases should be clearly identified as "reserved for HVAC" on construction prints. Aligning wall studs and floor joists (a practice recommended with advanced framing) greatly facilitates horizontal-to-vertical duct transitions. Decisions about using central or individual returns and the location of the return air ducts should also be determined early in the design process.

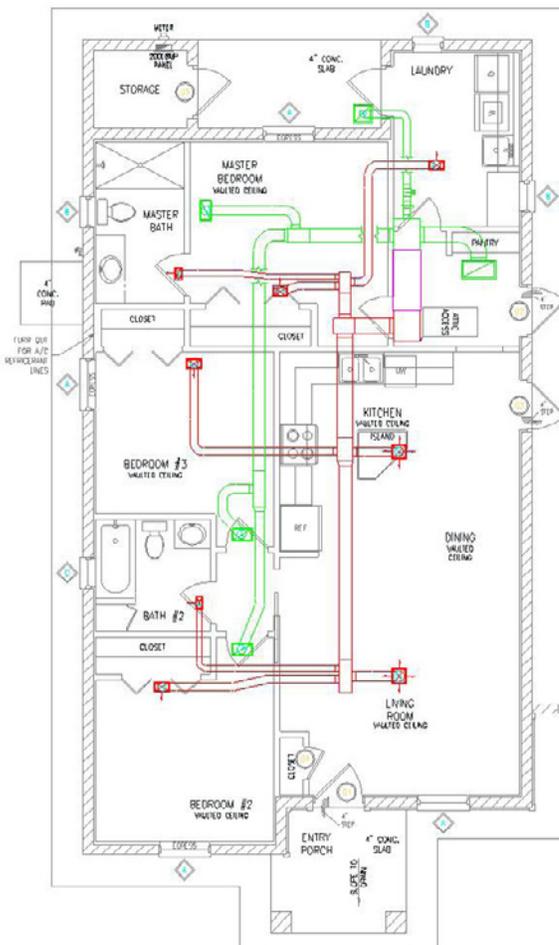
Coordination of the duct design and the framing plan is especially important if one goal is to keep all ductwork inside the thermal boundaries of the house. Keeping all ductwork inside may require the use of soffits that reduce ceiling heights. Alternatively the designer may decide to run the ducts through the floor joists, particularly in multi-story houses. This can be facilitated by aligning floor joists with duct runs or using open-web floor joists. However, these decisions cannot wait until field installation; they must be made at the design stage (Burdick 2011).

**Key Lessons Learned**

- Keep the duct layout short, straight, and simple for best performance.
- A final framing plan for each floor must be obtained as soon as possible in the design process because it is the plan that dictates the positioning of ductwork and air-handling equipment. Better yet, the framing plan and HVAC design should be coordinated so that the framing can accommodate an efficient layout wherever possible.
- The filter should be located where it can be easily accessed by the homeowner.
- Building cavities should not be used as ducts to deliver air to or from the HVAC system; all supplies and returns should be sealed, insulated ducts.



FSEC worked with Tommy Williams Homes of Florida to design a compact duct system with ducts located in dropped ceilings inside the home and supply registers coming directly off the trunk line wherever possible.



Duct layout should be determined early in the design process. Duct runs should be short and straight with inside throws and minimal bends.

“In standard construction, the mechanical systems are an afterthought. Your typical builder will frame the house and then the mechanical contractor will figure out how to route the ductwork around the framing. From the start, we wanted to design an integrated solution.”

**Kevin Brozyna**, IBACOS

**REFERENCES**

**Burdick, A.** 2011. *Advanced Strategy Guideline: Air Distribution Basics and Duct Design*, Prepared by IBACOS for the U.S. Department of Energy Building America Program, [http://apps1.eere.energy.gov/buildings/publications/pdfs/building\\_america/strategy\\_guide\\_air\\_distr.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/strategy_guide_air_distr.pdf)