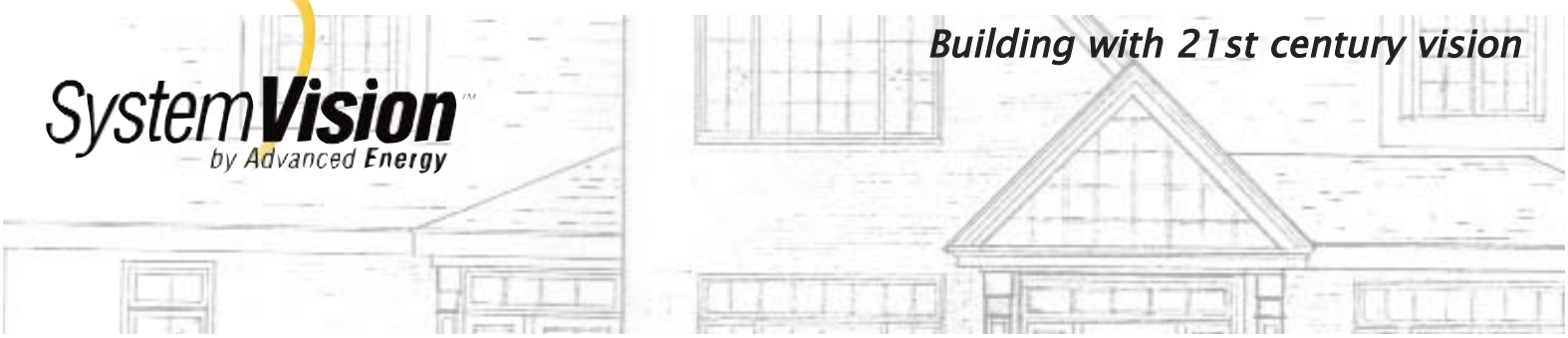

Building Trends (Even Good Ones) Can Lead to Trouble
by John Tooley

Trends in home building appear and disappear in response to developments in construction techniques and changes in consumer tastes. Some of these trends – such as improved air sealing and tighter homes – have a definite positive effect on the operation of the home. Others trends, like the inclusion of vent-free gas fireplaces, may be argued to have both positive and negative effects. When examined individually, these changes may show a significant or not so significant impact on the house system. But as recent research has shown, when viewed together, these building trends can have a cumulative effect on the house system, often with unfortunate results.

The House as a System

For years, building science professionals have presented the idea of looking at a house as an interactive system, rather than as a bunch of isolated parts. Research has proven that changing any part of the house has an effect on the entire system, sometimes positive and sometimes negative. Each and every change to the house system must be evaluated as to its effect on moisture migration, heat flow, air flow, and air quality. Only then can the builder provide maximum occupant comfort and safety, and ensure the efficiency and durability of the house.

Changes in Construction

Changes in home construction techniques have resulted in houses that are significantly tighter than in the past. A tight home, sealed properly against leakage, results in lower energy bills and increased comfort for the homeowners. These changes have been driven largely by three factors:

- Higher material prices.
- Rising energy costs.
- Higher demand for comfort and convenience.

Building Trends

Some of the building trends outlined below are positive changes in home construction techniques. Many of the changes were initiated to reduce energy consumption. Others resulted from efforts to reduce construction costs or improve homeowner comfort, and may or may not represent positive changes. Each of these trends has some effect on the house. But when several of these changes are implemented in the same house, they can often have a cumulative effect, often with disastrous results to the house system.

Tighter Houses

Today's houses are built much tighter than houses in the past. Proper sealing protects against air leakage, keeping conditioned air inside the house, and unconditioned air outside. In general, a tighter house means more comfort and lower energy bills. However, homeowners today rely much more on air conditioning rather than on natural ventilation, often keeping their homes closed up year-round. In older, leaky homes, this didn't present much of a problem. But in today's homes, some negative side-effects of a having a leakage-free house are beginning to make an unpleasant appearance.

Odors from pets, cooking, or even new carpeting or paint, can become trapped inside a tightly sealed house. Likewise, without proper ventilation, pollutants, radon, or vapors from household chemicals may build to unacceptable levels, causing health concerns. Homeowners themselves may even contribute to problems by burning scented candles to mask odors, which leads to soot deposits under doors and in other unlikely places where the air flows by.

Vent-free Combustion

Lately, many homeowners and builders are choosing to include vent-free combustion devices – such as gas fireplaces or space heaters – in their home designs. While these appliances may add a certain amount of perceived comfort or ambience to a home, they have the very unpleasant effect of releasing 100% of their combustion gases into the living space of the home. In tighter homes with less natural ventilation, these combustion gases (particularly carbon monoxide) can cause serious health con-

cerns.

If dumping combustion products into the air wasn't bad enough, vent-free heaters also release roughly one gallon of water vapor into the air for every 100,000 BTU of heat delivered. Without proper venting, this additional water vapor may contribute to moisture problems within the home.Other vent-free combustion devices, such as gas-fired stoves and ovens, are often overlooked in their effect on the house system. These devices are often not equipped with adequate ventilation to draw off combustion gases, and so contribute to both pollution and moisture problems within the home.

More Exhaust Fans

Newer home designs are including more and more exhaust fans, such bath and kitchen vent fans, central vacuum systems, range-top fans, attic ventilator fans, radon fans, and clothes dryers. These fans compete with each other for air during operation. With so many different fans fighting for air, some may become starved, and fail to do their job properly. In addition, these fans can rob air from vented combustion devices such as fireplaces, wood stoves, water heaters, and furnaces. This can cause these combustion devices to fail to draft properly and even back-draft, allowing combustion gases to enter the home.

One simple fact about exhaust fans is this: for every cubic foot of air exhausted out of the home, another cubic foot of air must be drawn in somewhere. And houses are not picky about where they get their make-up air, which can come through chimneys, unused vents, or other holes. So unless exhaust fan air requirements are taken into consideration during the home design, their operation can have a significant effect on many other parts of the house system.

Lower Vent and Chimney Gas Temperature

In an effort to save energy, water and space heating appliances have become much more efficient. While this is obviously a good thing for both the homeowner and the environment, it does present a certain, often-overlooked drawback: lower vent gas temperature means lower draft pressures to exhaust the combustion fumes from the home. Once again, failing to look at the impact on the house system can result in backdrafting, flame roll-out, or carbon monoxide and other combustion gases being drawn into the home.

Forced Air Systems

Forced-air heating systems are more popular today than baseboard electric, hydronic, or any other static system. Distribution fans for forced air systems typically move 800 – 2000 cubic feet of air per minute. A properly-designed and sealed duct system allows efficient distribution of the heated air to various parts of the house. But leaky duct systems – which, unfortunately, includes most installations – can cause severe pressure differences between different areas of the house. This can lead to increased infiltration of unconditioned air into the home.

Fewer Return-Air Inlets

Forced-air systems today are often designed with only one return-air inlet located in the main body of the house. This design reduces the complexity and cost of the air delivery duct system. However, it can often result in severe pressure imbalances within the home, when not taken into consideration as part of the house system.

With only one air-return inlet in the home, closing an interior door can suddenly change the entire pressure balance of the house system. Since supply air delivered to the closed room has no path for return, the room becomes pressurized. Air in this pressurized room is then forced out through any holes it can find, such as electrical outlets, gaps under doors, or around window sills.

With one room in the house pressurized, the rest of the house becomes depressurized. All of the air lost from the pressurized room must be replaced by air entering the house through other openings. So the house draws air in through the largest available holes with the least resistance, which may be the chimney, the vent stack for the hot water heater, the dryer vent, or other holes. In addition to drawing in unconditioned air, the air-handler is now competing for air with the vent fans, the fireplace, and other combustion devices. And since the air-handler is much stronger than any of the other draft sources, those weaker sources often become starved for air.

Higher Air-Handler Fan Flow

When fans were first fitted to the older, gravity-fed furnaces, they only pushed about 90 cfm of air through the home. Such modest air flow had little effect on leakage, particularly since the older homes were so leaky to begin with. But when forced-air furnaces were introduced, they provided air flow of 600 to 1000 cfm. Now, modern air conditioners and heat pumps push as much as 450 cfm per ton (1350 cfm for an average 3 ton unit). This tremendous increase in air flow results in corresponding increases in leakage into and out of the house and duct system. And in today's tighter houses, such leakage has a much more significant effect on the home's environment, comfort level, and energy use.

Open Framing

Traditional building techniques use 2x8s or 2x10s to frame floors, which are then covered with sheetrock and/or flooring. This method results in a number of separate floor joist cavities, each one fairly well separated

from the rest. Leakage into or out of any one of these cavities only affects a small space.

Due to the rising price of lumber, a new floor framing method has emerged, using open-webbed floor trusses and engineered floor joists. This system not only reduces material costs, but also provides space for electrical wiring, plumbing, and ductwork. However, this design also means that the entire floor space acts as one large (and unconditioned) cavity. Sealing all openings into this cavity is a difficult task that is seldom done correctly. Leakage into or out of this floor cavity can now have a significant effect on the rest of the house system. Once again, in older, leaky houses, this change in flooring construction would not have a great impact. But in new, tighter homes, it can cause significant problems.

Similar changes are occurring in wall construction. Instead of traditional framing using wooden 2x4s, walls in new homes are often built using metal studs. Each of these studs is formed with a large hole in its cross-section, to allow for bracing and wiring installation. Since these holes aren't sealed, the entire wall in effect becomes a single, large, unconditioned space. Common wall openings such as electrical outlets and other fixtures allow leakage into and out of this unconditioned space, affecting the entire house system.

Larger HVAC Equipment

With older, leaky homes, the simple solution for heating and cooling shortfalls was to increase the capacity of the equipment. When it comes to furnaces and air conditioners, many builders and homeowners still mistakenly assume that "bigger is better." But in today's homes, oversizing HVAC equipment seldom results in improved comfort or performance. Not only is oversized equipment a waste of money for the homeowner, it can also cause a variety of operational problems, including short cycling, inadequate moisture removal, noisy operation, and shortening of equipment life. Oversized air-handlers can lead to overpressurization of the home, and increased leakage rates. For proper operation then, the HVAC system must be sized properly in consideration of the entire house system.

Increased Insulation (R-value) vs. Proper Installation

To provide increased energy efficiency, homes today are designed with higher and higher levels of insulation in the walls, ceilings, and floors. But poor installation techniques that leave gaps, voids, or compressions, drastically reduce the effective R-value of the insulation. Improper installation of the insulation in a home can actually encourage mold growth, moisture damage, and higher energy use. Properly installed, the performance value (P-value) of thinner insulation may actually exceed that of higher R-value insulation that was installed poorly. Effective installation of the insulation helps to maintain the temperature of the conditioned air inside the home, while poor installation can reduce the overall efficiency of the home system.

Home Offices

In the last ten years, the number of people who telecommute or work in home offices has more than doubled. In today's economy, this trend will certainly continue. And as people spend more time working from their homes, the home systems see an increase in energy use, moisture vapor, and use of HVAC systems and other appliances. As noted earlier, each of these factors has an effect of the home as a system. Extended time within the home also means that the occupants are exposed to any pollution or other contaminants trapped inside for longer periods of time. This makes the issues of infiltration, leakage, and ventilation even more important.

Solutions

Each of the building trends outlined above has an effect on the home system – some positive, and some not so positive. These changes in building design and construction techniques often have a cumulative effect, causing unanticipated problems with energy use, comfort, safety, and durability. Each of these changes – and their impact on the home system – must be taken into consideration, and attempts made to correct any damaging effects they may have on the home.

The table below identifies each of the trends outlined in the article, and lists the solutions needed to prevent any adverse effects on the house system.

Trend Solutions

Tighter houses.

- Install appropriate ventilation.
- Test for pressure zones, and initiate appropriate fixes.
- Install insulation properly.Vent-free combustion.
- Eliminate unvented and vent-free devices.
- Ventilate all gas cook stoves.

More exhaust fans.

- Seal all leaks to attic, crawlspace, and other unconditioned spaces.
- Determine fan flow rates, and add make-up air to eliminate pressure changes

.Lower vent gas temperature.

- Separate intake from house air.
- Ensure sealed combustion.
- Forced ventilation of combustion devices.

Forced air systems.

- Seal duct systems.
- Design adequate ventilation.

Fewer air-return inlets.

- Design return air flow paths across interior walls.

Higher air-handler flow.

- Ensure adequate return flow paths.
- Properly-sized equipment.

Open framing.

- Block and air seal all cavities.

Larger HVAC equipment.

- Size equipment based on designed conditioning loads.

Increased insulation.

- Ensure proper installation, with no gaps, voids, compressions, or wind intrusion.Home offices.
- Install adequate ventilation.