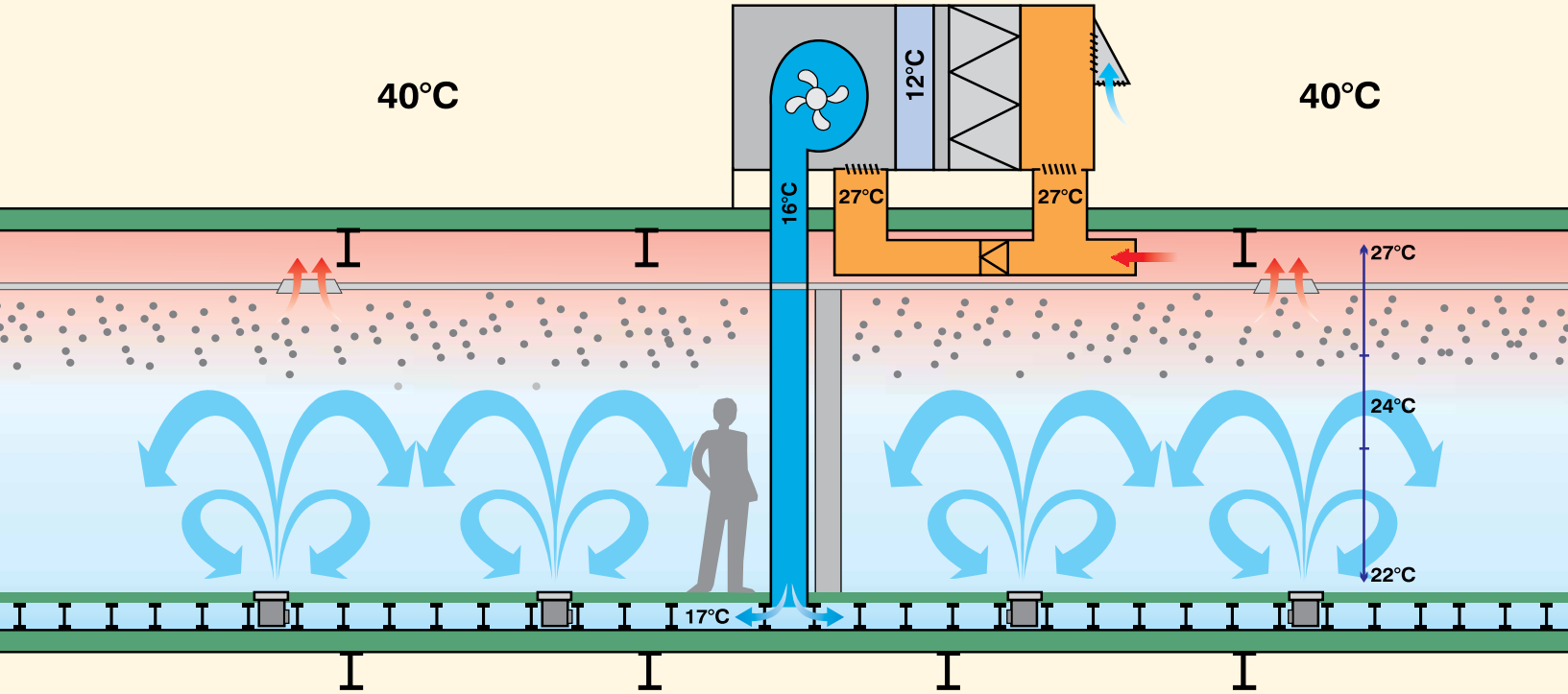

Under Floor Air Distribution (UFAD)
goes mainstream in the global HVAC industry

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Many years back, probably in Europe, most likely from computer room experience, some brave engineer had the insight to pressurize the volume under his raised floor in an office application. This pressurized volume acted like a duct or "Supply Airway". More than a hundred million square feet of applications later, many or even most engineers see this technology as having a place in the mainstream of HVAC design.

Certainly there are those who haven't adopted the strategy, or will be slow to do so. I was one of those. The Variable Air Volume (VAV) underfloor products first introduced by York International in the late 1990s were developed in some office space I had leased to an affiliated company. These new systems were significantly different than earlier Displacement Ventilation systems first devised for large open plan buildings with a high occupancy level such as airport terminals and lecture theatres. These early innovators showed me this "exciting new idea" in the fall of 1997. My company was then a leading HVAC distributor in the Midwest USA. I looked at these guys like they were from Venus (the planet). "No reasonable real-estate owner, or engineer is going to put a raised or false floor in a regular building, just to avoid ducting overhead, or whatever silly reasons you suppose", was my comment. Surely this was just another crazy idea, concocted by some aging dreamers. Perhaps this technology would be used by the government (who doesn't care what things cost) or on the West Coast of the USA where they are known to do crazy things. So, like the guy who said the Beatles couldn't sing, I ignored Underfloor Air Distribution (UFAD) for more than 2 years and went on my merry way.

Many of us engineers missed a sound education in marketing while in college, because we were struggling to pass "Mechanisms and Dynamics of Machinery" or "Thermo". For those, like myself, I offer the Roger's Bell curve (and invite study of the Bass Diffusion Model of concept adoption). This example model below refers to a farmer's adoption of a new seed technology, (hopefully this does not insult any farmers reading this article):

About the Authors

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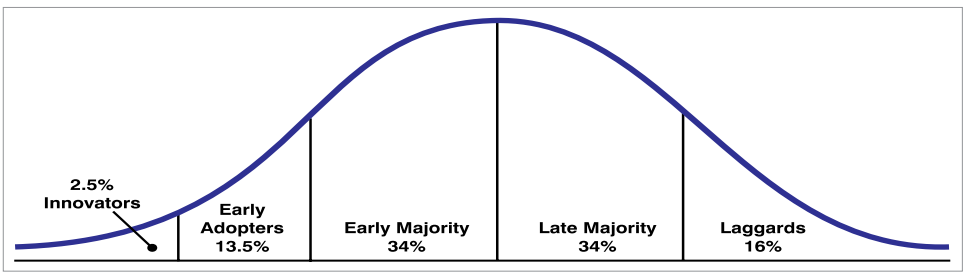

Rogers Bell Curve: The example model shown refers to a farmer's adoption of a new seed technology

The report summarized the categories as:

- ***Innovators*** - had larger farms, were more educated, more prosperous and more risk-oriented
- ***Early Adopters*** - younger, more educated, tended to be community leaders
- ***Early Majority*** - more conservative but open to new ideas, active in community and influence to neighbors
- ***Late Majority*** - older, less educated, fairly conservative and less socially active
- ***Laggards*** - very conservative, had small farms and capital, oldest and least educated

To those descriptions above I would add that many Innovators and Early Adopters make "the proper application of new technology" a differentiator in their business. Laggards will not adopt a new technology until it becomes law. The shape of the curve is almost always as above but speed of adoption varies as the complexity of the system, and the price of change. Better, simpler, lower cost changes are adopted much more quickly. Many in the market say: We won't change technologies until "the pain of not changing exceeds the pain of change".

Certainly there are those who have jumped in early and mis-applied the technology (it is tempting to give specific examples, but I resist). Some of these are in a position where they have to (loudly) fault the technology to explain their troubled projects, because not to do so, would be to admit their liability. Happily you can now benefit from the experiences of others, with less pain. The last 5 years of equipment and system development have led to many more choices and lower first costs. As certain products have been repeatedly chosen as wise strategies, several manufacturers have invested in better tooling to compete for those commodity sales at a lower cost.

There are many market drivers for UFAD. The Raised Access Floor (RAF) manufacturers have realized that UAFD is a beneficial part of their system and helps sell more access floor. They have supported and helped spread the technology. Architects and designers have adopted UFAD and RAF as part of the Sustainable Architecture trend. The U.S. Green Building Council (USGBC) and Leadership in Energy and Environmental Design (LEED) and similar GREEN associations around the world, recognize and appreciate the benefits of this strategy. It truly has gotten to the point where; nearly all of our time (in the UFAD sales business) is spent with clients who already know they want RAF, and probably UFAD, and simply want to implement the technology correctly and efficiently. The purpose of this article is to help do exactly that.

One might ask; why haven't I seen more of these jobs in my area? (city, state, country)? I submit that: generally speaking engineers and constructors are risk adverse, and understandably so. They are rarely paid to innovate. The HVAC industry really doesn't have the marketing funds to advertise, like some of the consumer markets have. The expansions of new ideas are slower, more viral. Design and construction cycles are very long in our industry. It is not uncommon for the timeline from project concept - till the end of warranty, to exceed 5 years. It is tough to "wait and see how the first 10 projects go in my area".

The turning point for me with this technology was when I put it in my own building, and then lived and worked in that environment. Upon visiting my office one day, a particularly conservative and stern school board president commented that: "The air just feels better in here; I don't need technical instruments to tell me. This is better air conditioning, we want the best." Seeing my customers get excited, really got me excited. Nine years and 30-40 million sq. ft. later, I am confident the technology will continue to grow.

Like any new construction concept, people associated with implementing the idea need training. UFAD is no different as it affects many facets of the construction process. When conducting "construction management" meetings for UFAD projects, I often tell a story to the group of impatient, skeptical, construction tough guys I am addressing: Sometimes I am hired by manufacturers, owners and contractors to fix troubled UFAD projects. My job is relatively easy: first off, it is 10 times easier to criticize than to create; and secondly, it is always the same things that cause troubled UFAD jobs.

No matter what your weather, no matter what your local construction practices, no matter what kind of building you are designing, there is probably an existing example application of UFAD for your type of building, somewhere.

ASHRAE does not endorse UFAD more or less than any other or any specific technology. They do however publish application guides for those interested in learning more about a certain strategy. One such guide was written by Fred Bauman of the Center for the Built Environment (CBE) at Berkeley. This guide was first published in 2003 and is currently being updated and improved by an ASHRAE TRG7 committee. This committee is comprised of architects, property managers, engineers, research scientists, manufacturers and owners. Some in the group openly oppose the technology, while many support it. The group will complete a new design guide inclusive of experience and lessons learned from a vastly larger installed base than existed in 2003. The new edition is scheduled to be published in early 2010.

Why put the air distribution under the floor? The actual reason the UFAD strategy is selected may differ from how it is financially justified. Many users pick UFAD because it is an interesting, new idea that actually works well, and they are anxious to gain

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GROWTH		
YEAR	**RAF* Industry Market in the US in sqft/year**	**UFAD %**
2002	16,492,000	1%
2003	16,896,000	16%
2004	16,524,000	40%
2005	16,672,000	44%
2006	17,992,000	44%
2007	21,552,000	58%
2008	25,500,000	66%
* Raised Access Floor		

Table 1: Recent RAF industry statistics showing growth of RAF and UFAD from 1% of the access floor projects in 2002 to 66% of the projects being designed with access flooring in 2008.

experience with UFAD to prove that their engineering/architecture firm, construction company, or building incorporates better ideas. Basically the 6 major reasons UFAD and RAF is used are:

- ***Better indoor air quality for occupants*** - better ventilation efficiency (depending on diffuser choice), definitely lower particulate counts in the breathing zone and improved thermal comfort and personal control for users.
- ***Better flexibility for reconfiguration of building services*** – Nearly every building user will reconfigure their space and furniture arrangement many times in the lifecycle to optimize the space to be more effective for the company using the space as needs change. Voice data and power wiring, piping, and air conditioning usually need to be changed to accommodate new space arrangements. This can be nearly impossible – and definitely more expensive - with other strategies.
- ***Lower energy use*** – This is primarily derived from lower fan energy because the UFAD supply airway operates at a much lower air pressure, and thus lower fan HP. Some climates use cool outdoor air (when available) as part of an "economizer" cycle. The hours where this strategy can be used are increased with UFAD because of the use of warmer supply air temperatures (61-67°F).
- ***Shorter floor to floor heights are possible*** – Most UFAD systems can be employed in a RAF of 8-12 inches finish floor height. 12" or higher is the norm. The return air passage need only be 6" in most cases, if a drop ceiling is used. Committing 18" total to A/C supply and return is often less than would be otherwise allocated. The difference can be translated into building height savings, additional floor(s) for the same building height or taller ceilings in the occupied space (enhanced head room). Significant savings in the region of 5-7% on total build cost have been achieved in buildings around the World.
- ***Better conformance to LEED and Green Building Requirements*** – Significant progress towards the USGBC LEED 2.2 (IGBC 1.0) requirements can be made with RAF and UFAD.
- ***Potentially Improved Real Estate Metrics*** – Studies in the USA have shown that "green buildings" have higher occupancy rates, above-market rental rates, and stronger valuations. A Green Building has been shown to give the owners a higher Return On financial Investment (ROI).

The evaluation of lifecycle cost of a building is not a simple thing. It is particularly difficult to forecast life cycle cost accurately because so many forward looking assumptions must be made. One of the most studied aspects of this is energy consumption. UFAD will usually provide significantly lower operating cost when compared to systems with similar operating conditions. The bottom line with RAF and UAFD is lower life cycle cost and better Return On Investment (ROI) for investors.

Some general steps to a successful project are:

- Secure a reasonable budget for the project. For certain types of buildings there may be a 1-5% premium to execute Green building strategies. Sometimes there is no premium. We know of a 200,000 square foot LEED Platinum Building built at no first cost premium.
- Work with design professionals who have experience executing these strategies. If these are not available locally, or your desired team is executing their first project, consider a design assist or review by an experienced firm. These reviews can be done for a surprisingly reasonable cost. Select the construction team by value, not just price alone.
- Hire design professionals for construction services throughout the construction of the project. Be sure to have a match between system capabilities and owner expectations.
- Maximize documentation of Green Build strategies and seek a LEED rating (or similar certification as available in your area). That way the owner/investors in the project will get a good rate of return in their green technology investment and will be more than willing to repeat the process.
- Engage an experienced firm to instruct the construction team on best practices for RAF and UFAD on site throughout the job. This construction management should have 3-4 phases: Before tender, pre-construction, during construction inspections and commissioning. Once again, this is a very low cost/high value tactic.
- Be proud of your accomplishment. Advertise the successful completion of the project, and its green features. This will likely secure repeat business for all on the construction team. If the project seeks tenants, this will increase occupancy.

UFAD is now well established in many parts of the World (USA, Northern Europe and Hong Kong). In some areas it is the system of first choice. As we continue to develop new markets, the same questions and concerns about the "new" strategy are asked. We would be concerned if good engineers were not asking these questions. Hopefully now, the answers are available.

This is a viable Mainstream technology. UFAD has come a long way in the last 10 to 15 years. Consider it with care for every project. Listen to a broad array of experienced professionals when designing and executing a UFAD/ RAF project.

1 Source quote Jack Geortner

2 Source Everett Rogers diffusion of innovations model

3 Source quote Quentin McArthur

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